40526

National Library of Canada
Bibliothèque nationale du Canada

CANADIAN THESES ON MICROFICHE

THÈSES CANADIENNES SUR MICROFICHE

NAME OF AUTHOR/*NOM DE L'AUTEUR* GRANTLEY WAINRIGHT WALROND

TITLE OF THESIS/*TITRE DE LA THÈSE* Minerals Policy Development Strategy in Guyana

UNIVERSITY/*UNIVERSITÉ* University of Alberta

DEGREE FOR WHICH THESIS WAS PRESENTED/ *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* Phd.

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* Spring 1979

NAME OF SUPERVISOR/*NOM DU DIRECTEUR DE THÈSE* Dr. Roger D. Morton

Permission is hereby granted to the NATIONAL LIBRARY OF CANADA to microfilm this thesis and to lend or sell copies of the film.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

L'autorisation est, par la présente, accordée à la BIBLIOTHÈQUE NATIONALE DU CANADA de microfilmer cette thèse et de prêter ou de vendre des exemplaires du film.

L'auteur se réserve les autres droits de publication; ni la thèse ni de longs extraits de celle-ci ne doivent être imprimés ou autrement reproduits sans l'autorisation écrite de l'auteur.

DATED/*DATÉ* 4th Dec. 1978 SIGNED/*SIGNÉ* Grantley W. Walrond

PERMANENT ADDRESS/*RÉSIDENCE FIXE*
122 South Ruimveldt Park
Greater Georgetown, Guyana,
South America

NL-91 (3-74)

National Library of Canada

Cataloguing Branch
Canadian Theses Division

Ottawa, Canada
K1A 0N4

NOTICE

The quality of this microfiche is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us a poor photocopy.

Previously copyrighted materials (journal articles, published tests, etc.) are not filmed.

Reproduction in full or in part of this film is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30. Please read the authorization forms which accompany this thesis.

THIS DISSERTATION
HAS BEEN MICROFILMED
EXACTLY AS RECEIVED

Bibliothèque nationale du Canada

Direction du catalogage
Division des thèses canadiennes

AVIS

La qualité de cette microfiche dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de mauvaise qualité.

Les documents qui font déjà l'objet d'un droit d'auteur (articles de revue, examens publiés, etc.) ne sont pas microfilmés.

La reproduction, même partielle, de ce microfilm est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30. Veuillez prendre connaissance des formules d'autorisation qui accompagnent cette thèse.

LA THÈSE A ÉTÉ
MICROFILMÉE TELLE QUE
NOUS L'AVONS REÇUE

NL-339 (3/77)

THE UNIVERSITY OF ALBERTA

MINERALS POLICY DEVELOPMENT STRATEGY IN GUYANA

by

Ⓒ GRANTLEY W. WALROND

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES
AND RESEARCH IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOLOGY

EDMONTON, ALBERTA

SPRING, 1979

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Minerals Policy Development Strategy in Guyana.

submitted by Grantley W. Walrond

in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in Geology.

....
(Supervisor)

....

O. J. Freeman
....

....

Hugh C Morris
....
(External Examiner)

Date ..November.20,.1978.

ABSTRACT

A strategy for mineral policy development is analysed principally in the context of the environment in which it will be applied. This environment is considered to be a composite of the national physiographic and economic setting, the structure and nature of the mineral industry, and the relevant sectors of the international economy. The study therefore, isolates for treatment such issues as Guyana's state of development, and its future prospects; the role of minerals in development; the structure of the mineral industry; the role of multinational corporations; the question of commodity prices, and closes with an analysis of rent, its distribution, and collection.

In particular, the thesis explores the opportunities for a contribution to development from the non-bauxite mining sector. The point is emphasized that Guyana is geologically a very favourable environment for potential occurrence of base metal mineralisation. From a complete review of the geology and stratigraphy of Guyana, a metallogenetic scheme is developed. The bases for the metallogenetic classification are known mineral or geochemical occurrences, and environment-type. The classification is then reinforced by analogies from similar environments elsewhere. Major zones of potential mineralisation are identified and an exploration strategy is elaborated.

An analysis of the existing government agencies which service the mineral sector reveal some problematic areas, and some recommendations for changes are advanced.

In particular, the creation of a state mining enterprise which would assume the detailed exploration function of the Geological Survey, is advocated. Rent collection schemes are analysed and a distinct preference for a Resource Rent Tax is forwarded.

ACKNOWLEDGEMENTS

I wish to express a sincere debt of gratitude to Dr. R. D. Morton for the unstinting support and supervision which he provided over the duration of this project. The friendship which he and his family have shown, has certainly contributed in a large measure to the relatively pleasant stay which I experienced while at this University.

To Dr. R. E. Folinsbee, from whom I have learned the meaning of thoroughness and precision, a special thank you is extended. Dr. W. D. Gainer has contributed significantly to the final form of this thesis, and his forthrightness will long be remembered and appreciated. Dr. T. S. Veeman is responsible for helping me develop an appreciation for resource economics concepts in the early stages of the program, and he is formally recognized for doing so.

Funds for this project were contributed by the Canadian Commonwealth Scholarship and Fellowship Committee. The Government of Guyana has afforded me leave of absence from my regular duties at the Geological Surveys of Guyana. To both of these organizations, I am indeed very grateful.

Many others have contributed in one way or another to the successful completion of this work. My friend, Dr. K. Hope, willingly supplied copies of his work; the support staff in the Geology Department especially F. Dimitrov, L. Shupenia and G. Milvain who gave generously

of their time and talents, and they are here recognized. N. Baichoo is credited for support on the difficult editorial problems encountered, and C. Gallagher for the time and effort devoted to the typing of the manuscript.

I am most grateful to Barbara - my wife - for coping with my eccentricities, and frustrations during the difficult periods of the program. Finally, this thesis is dedicated to my parents - Trim and Viola Walrond - who made it all possible.

TABLE OF CONTENTS

CHAPTER PAGE

I Introduction: Objectives and Scope of Study.. 1

II Physical and Economic Structure of Guyana.. 9

Location, Physiography and Climate..... 9

An Historical Note.................... 14

Demography and Labour Force............ 15

Sectoral Origin of Domestic Product.... 20

Expenditures, Savings and Debt......... 25

Balance of Payments and Trade.......... 35

Price Level and Wages.................. 43

The Development Prospects.............. 47

III The Mining Industry, Exclusive of Bauxite... 63

The Gold and Diamond Industry.......... 63

Method of Production................... 65

Organizational Structure............... 84

Quarry Products........................ 88

The Government Presence................ 95

The Miners Assistance Fund............. 111

Summary................................ 114

IV Characteristics of Mining Industries........ 117

Determinants of Mineral Resource Availability............................. 122

Market Structure....................... 129

Fundamentals of Market Classification.. 129

Observations of Market Patterns........ 134

CHAPTER PAGE

Sources of Concentration.............. 145

Price Stability and the Commodity Problem.......................... 150

V Minerals as a Generator of Economic Growth/Development.................... 165

General Statement..................... 165

Indices of Performance................ 167

Assessment of Impact of Mineral Industry............................ 170

The South American Experience.......... 175

Foreign Investment and the State....... 178

Options Open to the State.............. 189

VI Geological Setting........................ 208

High Grade Metamorphics: The Kanuku Complex............................ 212

The Kanuku Granulites.................. 215

Basinal Sequences...................... 226

The Barama-Mazaruni Supergroup of the Northern Basin........................ 227

The Bartica Assemblage................. 236

Guyana Shield Correlatives of the Barama-Mazaruni Group.................. 241

The Kwitaro Group of the Southern Basin............................... 243

Shelf Sequences........................ 246

Cratonic Sequences..................... 254

Graben Sequences....................... 257

Mafic and Ultramafic Intrusives........ 259

Granitoids............................. 263

Global Setting of the Guyana Rocks..... 267

CHAPTER PAGE

VII Metallogenic Classification and Indentification of Targets.......................... 271

The Kanuku Ancient Platform............ 279

The Barama-Mazaruni Greenstone Belt.... 281

Kwitaro Continental Supracrustals...... 298

Burro-Burro and Kuyuwini Shelf Facies.. 300

Granitoid Rocks........................ 303

Roraima Cratonic Sequences............. 304

The Takatu Graben...................... 307

VIII Extraction of the Public Benefits........... 308

Rents and their Disposition............ 310

Sources of Rent........................ 313

Distribution of Rent................... 315

Collection of Rent..................... 319

Claimstaking System.................... 320

Leasing Systems........................ 322

Concession Systems..................... 338

Government-Run System.................. 340

IX Summary, Conclusions and Recommendations.... 342

Bibliography.................................... 356

APPENDIX 1. List of materials sent to geologists for geostatistical analysis............ 383

APPENDIX 2. Guystac Group of Companies............ 392

APPENDIX 3. Gold Production 1884-1975............. 393

APPENDIX 4. Gold Production from 1955 to 1974...... 396

APPENDIX 5. Operator's Questionnaire.............. 397

APPENDIX 6. (1) Distribution of Claims by District for 1965......................... 399

PAGE

APPENDIX 6. (II) Distribution of Claims by District for 1970........................... 400

(III) Distribution of Claims by District for 1975............... 401

APPENDIX 7. Generalisation of Scale of Mining Operations usually associated with specific Minerals......................... 402

APPENDIX 8. Classification of Mineral Resources and stages of geological investigation for utilisation of raw materials in Guyana................................ 403

APPENDIX 9. Principal outlets for Mineral and Metal Products........................... 404

APPENDIX 10. (a) Reserve - Output and Resources - Capacity in the nickel industry... 405

(b) Reserve - Output in Noranda Group of Companies...................... 406

(c) Reserve - Output for Amax Co. Ltd. 407

APPENDIX 11. Investment Requirements in the Copper Industry............................. 408

APPENDIX 12. (a) Prices of Selected Minerals and Metals........................... 409

(b) Prices of Selected Agricultural Products......................... 410

APPENDIX 13. Non-fuel Minerals: Capital Cost per Metric ton of annual production capacity............................ 411

APPENDIX 14. List of Gold Prospects................ 412

APPENDIX 15. Table of Fees........................ 417

(a) Summary of Estimates of Revenue... 418

LIST OF TABLES

TABLE PAGE

1 (a) Population, Labour Force, Employment and Unemployment.......................... 17

(b) Total Employment by Sector................ 19

2 Sectoral Origin of Gross Domestic Product................................ 21

3 Indicies of Physical Output of Selected Commodities.............................. 23

4 Expenditure on Domestic Product........... 26

5 (a) Gross Domestic Capital Formation.......... 27

(b) Expenditure and Saving from Personal Income.................................. 28

6 Central Government Current Expenditure, 1966-1976............................... 31

7 Central Government Capital Expenditure, 1966-1976............................... 33

8 Central Government Total Expenditure, 1966-1976............................... 34

9 Balance of Payments, 1962-1976............ 36

10 Sectoral Origin of Exports and Imports.... 38

11 Value of Principal Exports, 1956-1976..... 39

12 Direction of Guyana's Foreign Trade....... 41

13 Consumer Price Index...................... 45

14 Annaual Data on Earnings and Man-Hours Worked.................................. 46

15 Gold Production, Export and Royalty....... 66

16 Gold Production by Districts.............. 67

17 (a) Income Pattern for Dredging Operations.... 73

(b) Cost Pattern for Dredging Operations...... 74

18 Distribution of Claims by District for 1965, 1970 and 1975....................... 78

TABLE PAGE

19 Diamond Production, Export and Royalty.... 80

20 Diamond Production by Districts.......... 81

21 Employment in Gold and Diamond Industry... 83

22 Comparative figures on Stone Production... 93

23 Summary of Capital expenditures for Geological Surveys and Mines.............. 08

24 Miners Assistance Fund.................... 112

25 Index of Concentration in the Mining Industry.................................. 136

26 Lithostratigraphic and Tectonic Evolution of Guyana.............................. 211

27 Chemical Analyses of Rocks from the Kanuku Complex, The Imataca Complex, the Cerro La Ceiba Migmatites Compared with Average Greywackes, Shales and Ocean Tholeiites... 221

28 Summary of Correlated Units in the Guyana and West African Shields.................. 242

29 Metallogenic Classification of Guyana..... 273

LIST OF FIGURES

FIGURE PAGE

1 Map of South America.......................... 10

2 (a) Map of Relief and Physical Features............ 13

(b) Map of Rainfall Distribution.................. 13

3 Graph of Gold Production (1884-1975)............ 64

4 Graph of Gold Production by month (1955-1974)... 71

5 Proposed Organisational Chart of the Ministry of Energy and Natural Resources................ 102

6 Map of the Guyana Shield......................... 210

7 Geological Map of Guyana......................... 419

8 Map of Mineralisation Localities in Guyana...... 292

9 Magnetic Interpretation Map...................... 293

"…. A bit of perspective would remind us that actually, few major human developments have taken place over the short term. Our pace of accomplishment is much slower than the rapidity of desire. It is perhaps too easy to conceive a major advance, certainly much too easy to promise it for political advantage and always hard and time consuming to bring it about."

(Raynolds, D.R.; 1967)

CHAPTER ONE

INTRODUCTION: OBJECTIVES AND SCOPE OF STUDY

The major focus of this enquiry is upon the elucidation of the potential contribution which the non-bauxite mining sector might make to the future development of Guyana. It seeks to establish the fact that the part of the Guyana Shield, which is represented by the State of Guyana, is geologically an attractive area for mineral exploration activity. As such, the study will attempt by analogy, to refute the notion that Guyana is poorly endowed with base-metal mineralisation.

This dissertation further seeks to establish the view that geology, economics and politics are all essential elements in mineral resource availability. As such, geological availability must be complemented by an adequate economic and political climate. The study therefore attempts to elaborate what might be considered as an 'adequate climate' in a Guyanese context. Arising out of these concerns, a general strategy for the development of a suitable mineral policy will emerge.

Guyana's mineral wealth is both a function of its original physical endowment and of the effectiveness with which this endowment is sought out and developed. An evaluation of this wealth must therefore take into account five important considerations namely:

(i) The physical extent of the known endowment and the technological and economic ease of its recovery.

(ii) The possibility of increasing the currently known quantum of resources.

(iii) The features of mineral resources which distinguish them from other resources.

(iv) The socio-economic, political, and institutional environment in which the minerals will be sought and developed.

(v) External factors affecting the development of the resources.

These are all set against a background concept that the level of living - actual and potential - is dependent on intelligent and rational use of the resource.

Naturally, geologic availability is crucial to the assessment and is a precondition to any economic evaluations. Hence, the procedure that will be adopted encompasses a geologic evaluation of Guyana in so far as it relates to the potential for mineralization. The point is clearly made that a plethora of information on Guyanese geology exists, but that the records are not at present in a form that would permit an easy assessment of the economic potential of the mineral resources. From the numerous, disparate sources, an attempt is made to synthesize the known geological, geochemical, and geophysical data, and by the principle of convergence of evidence, suitable mineral environments will be delineated. Geologic theory and concepts of ore formation are used to facilitate targetting of conventional mineral deposits in favourable regions. In this regard, one must recognize that Guyana occupies a part of the Guyana-Brazil Shield and analogies will be sought in similar environments which occur in the various shields of the world, while particular attention will be focused on the neighbouring countries with whom Guyana shares a common geologic environment. Chapter 6 is devoted to this segment of the enquiry, and the geology of Guyana will be discussed with this bias in mind. In particular, a pre-Atlantic reconstruction will be drawn on, so that possible analogues in West Africa may be examined.

After developing an appreciation for the geological setting, the focus of attention is then shifted in Chapter 7 to a broad delineation of metallogenic provinces in Guyana. This study recognizes that there is a regrettable shortage of good geochemical data on Guyana, and it proposes to define these provinces principally on geologic inference. The original intention was for a two-pronged attack, which would be:

(i) Synthesis of published material and use of geologic inference

(ii) A statistical appraisal of the likelihood of mineral occurrence.

In the latter approach, a subjective probability function is generated based on the accumulated knowledge of experienced geologists, who become the control area instead of a known geographic area as is done in multivariate analysis. This work was pioneered by Harris, Freyman, and Barry (1970), and has been used quite successfully in Western Canada. Thirty questionnaires of the kind found in Appendix 1 were sent to geologists who had first-hand experience of the geologic setting in Guyana. Unfortunately, the response was very poor, and a meaningful sample size was not obtained. However, the few responses which were obtained were used to reinforce the geologic inference approach.

In the latter part of Chapter 7, the focus of attention becomes even more pointed as an attempt is made to identify specific targets. A tentative schedule is then drawn up for the order in which ~~the~~ investigation should proceed. Whenever possible, an attempt is made to quantify, albeit in a crude way, the economic prospects of the various deposits.

Mineral policy must be viewed as a subset of the myriad of sectoral policies, all of which give content to the concept of the nation. Before a mineral policy can be advocated, the environment in which it will be implemented must be thoroughly understood. Chapter 2 is devoted to isolating the essential features of the Guyanese economy which will determine the type of policy to be advocated. In particular, an attempt is made to show that structurally, Guyana is basically an underdeveloped economy, displaying many of the features so characteristic of underdevelopment worldwide. An opportunity is taken at that point to promote some of the views which this author considers germane to economic progress in Guyana. Emphasis will be placed on the implications of small size for growth and development and from that discussion, the general environment for the mineral policy will be established.

Guyana has enjoyed a long history of mining activity, principally in the form of a developed bauxite industry which has depicted strong enclave characteristics. To a lesser extent, but for an equally long period, gold-and diamond-placer operations have been firmly etched into the Guyanese scene. These operations are typically of an extremely small scale, and can best be considered as artisanal in nature. Quarry products represent the next important mining item in Guyana, and even though they are of more recent parentage, their importance has grown considerably to meet the development needs of a growing society. This thesis takes the view that the bauxite industry is already well established, and is run by extremely competent people, hence it will be excluded from this investigation. It will only be considered as circumstances dictate. The enquiry then proceeds in Chapter 3 with a detailed look at the other relatively unorganized mining ventures i.e. gold, diamond, and quarry products. It attempts to bring to the fore, the reasons for the poor performance of this sector. Production methods, and economic relationships will be described in an attempt to evaluate the state of these sectors. The chapter concludes with a look at the relationship of government to mineral related activities. It further probes into the organizational structure of the affected government agencies, and proposes adjustments which could make the institutional arrangements consistent with increased productivity.

Having surveyed the Guyanese environment generally in Chapter 2, and specifically in Chapter 3, the discussion then turns into an analysis of mineral commodities. The rationale for the approach is based on the notion that mineral policy cannot be developed unless minerals are understood. Chapter 3 focuses on the characteristics of mining industries. It develops from the clarification of a few definitional problems, then broaches the question of the determinants of mineral resource availability. Following this, an analysis of the typical market structure found in mineral industries is investigated, and the chapter closes on the problems of pricing and price stability. Throughout the discussion, the focus of attention is centred upon the circumstances which a mineral producer - be it a multinational corporation or a state-run enterprise - must be prepared to handle.

This entire work is development-oriented, and Chapter 5 investigates the possibilities for mineral-led development. After a brief look at the indices of performance, an assessment is made of the impact of mineral industries upon various economies. In particular, the South American experience will be closely scrutinized. At an early stage, it was recognized that mineral development in a number of countries whether developed, medium-developed or underdeveloped, has an organic connection with foreign investment since the locus of occurrence is not necessarily the locus of consumption, while the uneven distribution of finance availability, dictates that capital must move to initiate production. The next section therefore tackles the controversial question of foreign investment and its role in an underdeveloped state. The chapter concludes with an appraisal of the options that are open to the state.

The penultimate chapter tackles the most crucial question of all, and that is, how should the public benefits be extracted. A general framework for a mineral policy is first presented and then the question of the distribution of the proceeds of mineral activity is considered. This problem is perhaps the most visible of all mineral activity discussions, and it probably has as many solutions as there are proponents.

Rents and their disposition have been a major problem for a very long time, and an attempt is made to synthesize the arguments with respect to the origin of rent, its function, and its distribution. Various distribution mechanisms are considered, and the relevance of each in the Guyanese situation is evaluated. Because this issue is what adds the final form to a mineral policy, a concerted attempt is made to air as many of the arguments as possible.

Finally, it is necessary that a strong word of caution be instituted. This dissertation attempts to predict the best available geologic sites and the best conditions necessary for the recovery of their contained minerals. It should never be read as if the minerals are already known to exist in the ground, as has so often been the practice in Guyana. It attempts to bring informed judgement to an assessment of a potential of occurrence, and does not infer that the relevant minerals will be found in those areas delineated. It attempts to systematize proposals for future exploration efforts in Guyana, while paying due recognition to the institutional, and socio-economic conditions which will determine the milieu in which these exploration efforts will be conducted.

CHAPTER TWO

PHYSICAL AND ECONOMIC STRUCTURE OF GUYANA

LOCATION, PHYSIOGRAPHY AND CLIMATE

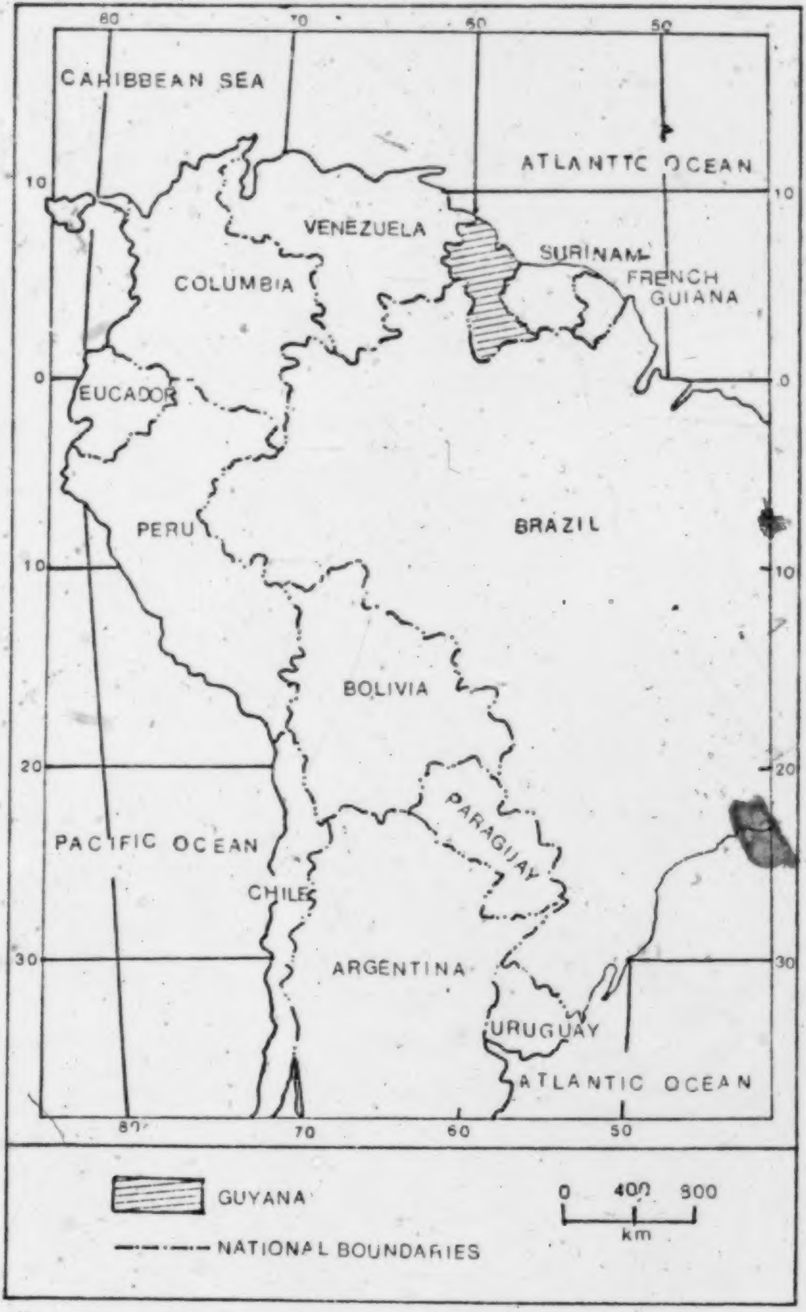
The Co-operative Republic of Guyana, known as British Guiana prior to achieving her independence from Great Britain on 26th May, 1966, is located on the north-east coast of South America between latitudes 1°N and 8° 30'N and longitudes 56° 30'W and 61° 20'W. As such, it is circumscribed by Venezuela to the north-west, Brazil to the west and south, Surinam to the east and the Atlantic Ocean to the north-east (see fig. 1).

Guyana is composed of four natural regions namely:

(i) The Low Coastal Plain
(ii) The Hilly Sand and Clay Region
(iii) The Interior Savannas
(iv) The Forested Highlands

As seen from fig. 2, the Coastal Plain is approximately 15 - 65 km wide, and at least 5 of these kilometres represent land reclaimed from the sea which at high tide is above the present outer plain. This physical fact has necessitated an extremely complex and costly system of sea defence and drainage to protect the relatively fertile silty clays, pegasse, and sandy reef-lands which have formed the basic support system of an essentially agricultural economy. South of the Coastal Plain is the Hilly Sand and Clay Region which covers approximately one-quarter of Guyana, and which is dominated by white pervious and relatively infertile quartz sands, and impervious

FIGURE I
SOUTH AMERICA


80
70
60
50
CARIBBEAN SEA
ATLANTIC OCEAN
10
VENEZUELA
SURINAM
FRENCH GUIANA
COLUMBIA
0
EUCADOR
PERU
BRAZIL
BOLIVIA
20
PARAGUAY
PACIFIC OCEAN
CHILE
30
ARGENTINA
URUGUAY
ATLANTIC OCEAN
GUYANA
NATIONAL BOUNDARIES
0
400
800
km

clays. This region supports most of the hardwood forests found in Guyana, as well as being host to the very important bauxite deposits, while the Continental Shelf which slopes gently northwards for 125 to 160 km forms home to luxuriant fish and shrimp growth.

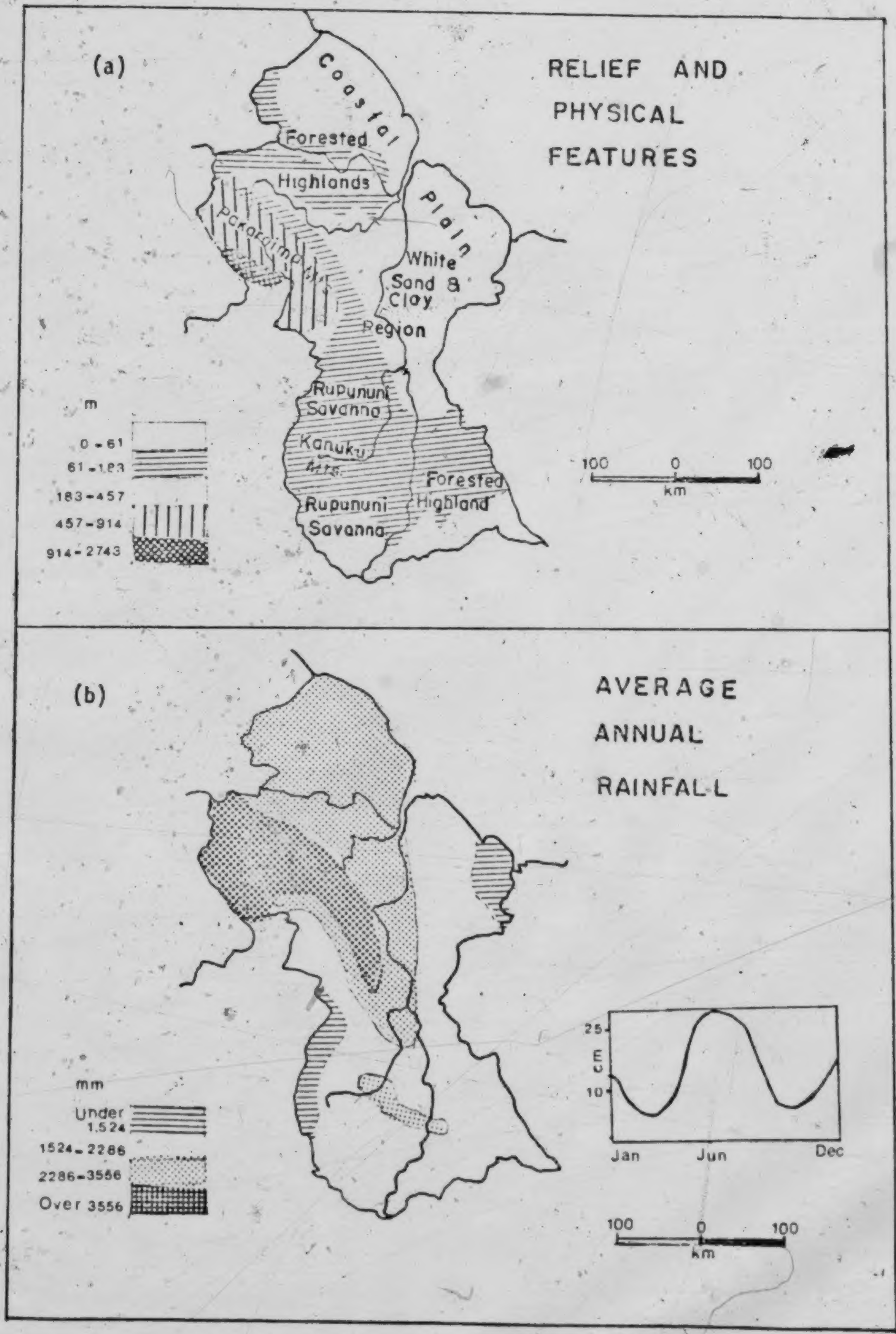
The Forested Highlands sector covers over 60% of the country and it can be divided into the Imataka Mountains in the north-west, the Pakaraima Mountains in the west, the Sierra Akari Mountains in the extreme south and the Kanuku Mountains in south-central Guyana. The mountains typically range in height from 300m to 1200m with anomalous regions such as Mount Roraima in the Pakaraimas which exceed 2700 m. This region which is sited on the crystalline basement is relatively uninhabited, and unknown, and forms the central area of focus in this dissertation. The Forested Highlands are interrupted in several areas to form the Interior Savannas which are represented by gently rolling hills on a plain with an approximate elevation of 100m to 220m.

The geomorphology of Guyana like most shield areas is dominated by a series of stepped planation surfaces - erosion bevels - or more specifically pediplains. McConnell (1962) recognized five such surfaces, the highest one being at an altitude of 915m and this was named the Kanuku surface by Berrange (1977), who found evidence of two more in the south of the country. The other surfaces in order of decreasing altitude are Kopinang (640 - 700m), Kaieteur (370 - 460m), Oronoque (275 - 300 m), Kuyuwini (230 - 260m), Rupununi (100 - 140m), and the Mazaruni at 70 to 90m elevation. Apart from its historical interest, these planation surfaces are extremely important as they are all marked by intense laterite development, and are responsible for the huge bauxite and iron deposits of Guyana, Venezuela, Brazil and Surinam.

The name Guyana is an Amerindian word for land of many waters, signifying the pervasive presence of many waterways which have thoroughly dissected the country, and leaving in their wake, the natural regions as described above. The main factors controlling the present drainage and river patterns are rooted in the original consequent drainage of the Guyana Shield, which is fundamentally an oval east-west trending boss giving the basic north-south consequent drainage pattern seen in fig. 2 (McConnell 1962). The east-west drainage pattern is subsequent, and like the consequent pattern, it is accentuated by lithology and structure.

Because of its equatorial location, Guyana typically has high temperatures and levels of precipitation. The average coastal temperature is about 27°C with an 8°C diurnal variation, and a 2°C annual variation. The interior has a slightly higher average of 28°C with variations from 18°C to 39°C. The coast receives a variable annual rainfall of 152 to 304 cm giving an annual average of approximately 230 cm. The Forested Highlands receive approximately 265 cm of precipitation, while the Interior Savannas receive only about 102 to 152 cm. As can be seen in Fig. 2b, the period from mid-April to August represents a major rainy season while mid-November to mid-January represent a shorter rain season. The intervening sessions are relatively dry, and they

FIGURE 2


(a)
RELIEF AND PHYSICAL FEATURES
Coastal
Plain
Forested
Highlands
Pakaraima Mts
White Sand & Clay Region
Rupununi Savanna
Kanuku Mts
Forested Highland
Rupununi Savanna
m
0 - 61
61 - 183
183 - 457
457 - 914
914 - 2743
100
0
100
km
(b)
AVERAGE ANNUAL RAINFALL
mm
Under 1,524
1524 - 2286
2286 - 3556
Over 3556
25
cm
10
Jan
Jun
Dec
100
0
100
km

represent the major periods in which any kind of geologic field work can be done. The ever-present north-east trade winds temper the effect of these high temperatures and high levels of humidity which are so prevalent in these regions.

AN HISTORICAL NOTE

Guyana was effectively occupied and ruled by the British for 170 years (1796 - 1966) except for a brief Dutch occupation in the 1802 - 1803 period. Prior to this time, the country changed hands, from one colonial power to the next, from its earliest recorded history of the unsuccessful Spanish attempts at colonization in the 1530's. The country, or parts of it, changed hands seven times from 1621 to 1803 among the Dutch, British and French, though the major occupants were the Dutch who for 174 years of the 182-year period, left a legacy of land utilization schemes which are prominent to this day. Farley (1955) and Daly (1975) have documented quite clearly how the historical evolution of this country was directly tied to the economic interests of the respective European powers, especially with respect to the search for gold, the need for agricultural products, in particular, sugar, and later the search for bauxite to meet the demands of an ever increasing British-American military machine. This history is also one of a few major foreign corporations such as The Dutch West Indian Company in the Dutch colonization period, Booker-McConnell Ltd., and Aluminum Company of Canada Ltd. (Alcan) in the British colonization period. These outriders of the colonization process, and their patterns of growth in the evolving Guyanese environment are extremely significant determinants in deciphering the present structure and the socio-political milieu which now characterizes the 'Guyana scene'.

DEMOGRAPHY AND LABOUR FORCE

The 215,000 sq km of what is now known as Guyana is home to just under 800,000 people (Guyana Government estimate 1977). Using the results of the last official census in 1970 as indicators, there are six ethnic groups of which the largest three are Guyanese of East Indian ancestry (52%), African ancestry (31%), and Amerindians (5%). Next in abundance are descendents of Portugese (1%), Chinese (0.4%), and there is a category of mixed ethnic origins (10%). The other 0.6% is made up of other Europeans, Syrians, and peoples of different nationalities. It is a sad fact of human life that this obvious richness of cultural diversity, must also be accompanied by racial tension and strife which is a perennial problem in the Guyanese scene, especially between the two major ethnic groups. While their introduction to Guyana was based on foreign economic norms (the Africans as slaves and the East Indians as indentured labourers to supplement if not replace freed-slave labour), (Daly, 1975), the long term prospects for economic development in Guyana will rest to a large extent upon the degree of co-operation that they display internally. It is beyond the scope of this thesis to delve into the 'politics of race' and the structure of the economy with respect to ethnic participation, but suffice it to say that the economy, viewed as an integrated whole, cannot survive, let alone grow, without all its parts.

Though an estimated population of 780,000 would indicate a population density of about 4 persons per sq km, actual figures reveal that 90% of the population lives on the relatively narrow coastal strip resulting in a population density of over 115 persons per sq km. Consequently, the hinterland which comprises about 85% of the total land area is virtually uninhabited and unknown. Security reasons apart, the increasing intensity in use of the narrow coastal strip, coupled with tremendous costs for sea defence, and other support services, and the possibility of vast wealth in the hinterland have resulted in recent governments promoting interior development while urging Guyanese to occupy the lands. More than 70% of the population is rustic, displaying an intense degree of rural agglomeration around the traditional agricultural products of sugar, rice and other foodstuff (Vining 1968).

The 1970 census indicated that the population was nearly equally divided between males and females and that it was growing at a rate of 2.8%. An interesting feature of Guyanese demographics is that approximately 60% of the population is made up of persons under 20 years of age. As observed by Hope (1972, 1976), the overall unemployment rate of 15 to 20% which exists in Guyana, takes monstrous proportions when one considers that the unemployment between the ages of 14 and 24 constitute about 42% of the labour force in that age group, which is about 35% of the total labour force. The labour force is about 30% of the total population and as revealed in Table 1a, it is increasing at an average annual rate of approximately 1.8%. Therefore, when viewed against

Table 1a

Population, Labour Force, Employment and Unemployment, 1946-70

(X 1000)

	Population	Population aged 15-65 yrs.	Labour Force			Employed			Unemployed		
			Total	Male	Female	Male	Female	Total	Male	Female	Total
1946	376.0	215.0	147.0	106.5	41.0	105.6	40.6	146.2	0.9	0.4	1.3
1960	560.0	282.0	175.0	134.1	40.9	124.5	36.7	161.2	9.6	4.2	13.8
1965	635.0	318.0	190.0	138.0	55.0	234.9	42.0	165.9	14.1	13.0	27.1
1970	714.0	350.0	210.0	150.0	60.0	133.0	45.0	178.0	17.0	15.0	32.0

Sources: Hope (1976), Bank of Guyana Annual Report (1975).

the fact that half of Guyana's population is of working age and the natural population increase is about 2.8%., the quantitative economic and social significance of the unemployment problem is truly grave, if these historic trends are to be extrapolated. Historically, women have had a poor participation rate in the labour force (18%), while the men had a participation rate of (47%). As more women voluntarily, and in most cases of necessity, opt for increasing participation, the visible unemployment statistics will grow larger by comparison.

The sectoral distribution of the labour force in productive economic activity shows a predominantly large, though decreasing contribution by the agricultural sector. Next, in order of significant contribution to employment is the manufacturing sector, followed by the engineering and construction sectors (see Table 1b). Though mining will be seen in a subsequent section to be significant in terms of its contribution to GNP, and export earnings, it shows a relatively poor performance (as is to be expected in such high capital-intensive activities) with respect to employment opportunities, since it engages less than 4% of the labour force. The services sector represents the largest contributor to current employment and as can be seen in Table 1b, it has been growing faster than the other sectors which in terms of employment opportunities display some measure of stagnation, if not decline, as noted in the case of agriculture. Brewster (1969), Thomas (1970), and numerous commentators on agricultural performance in Guyana, attribute

Table 1b

Total Employment by Sector

	1960		1965		1970	
	Employment	%	Employment	%	Employment	%
Agriculture	59 790	37.1	57 975	34.9	57 400	32.2
Mining and Quarrying	6 063	3.8	5 576	3.4	6 100	3.5
Manufacturing	26 308	16.3	26 806	16.2	27 800	15.6
Engineering, Construction and Housing	12 856	8.0	9 331	5.6	14 400	8.1
Other Services	56 183	34.8	66 212	39.9	72 300	40.6
TOTAL	161 200	100.0	165 900	100.0	178 000	100.0

Sources: Hope (1976), Bank of Guyana Annual Report (1975).

the declining employment in agriculture as principally a function of increased mechanization in the sugar and rice industries. The large growth of employment in the services sector reflects to a great extent, the increasing influence of government as new institutions are developed to meet the challenges of development.

SECTORAL ORIGIN OF DOMESTIC PRODUCT

Table 2 presents a sectoral origin of gross domestic product (GDP), and it is immediately obvious that the services sector is the largest contributor to output. It averages about 40% of GDP and its main contributor is Government which increased 300% from 1965 to 1975 (G $40 million in 1965 to G $160 million in 1975). It is indeed one of the fastest growing components of the GDP and had there not been significant price distortions (in an upward direction) in the world commodity prices in 1974 and 1975, particularly sugar, its steady increase from 12% of the 1965 GDP to 21% of the 1973 GDP would go unchallenged. Other services such as communication, transport, distribution, etc., have retained their relative proportions to GDP over the 1965-75 period. This phenomenon of the growth of Government accurately reflects the political, and socio-economic underpinnings of the present Guyanese society, which has embarked on a road of socialist reconstruction (Burnham, 1969).

At the opening of this chapter, Guyana was referred to as an agricultural economy. From Table 2, it is immediately evident that agriculture is a significant component of productive output in Guyana. This importance is underlined

Table 2

Sectoral Origin of Gross Domestic Product

(Millions of Guyana dollars and percentages)

Year	Agriculture[a]		Industry[b]		Services[c]		Total	%
	Amount	%	Amount	%	Amount	%		
1965	96.0	29.5	96.0	29.5	133.0	41.0	325.0	100
1970	109.0	23.3	170.6	36.5	187.9	40.2	467.4	100
1971	123.9	25.0	168.4	34.0	203.0	41.0	495.2	100
1972	126.2	23.8	174.1	32.9	229.2	43.3	529.3	100
1973	126.9	22.0	170.6	29.6	279.0	48.4	576.4	100
1974	322.8	37.3	220.6	25.5	321.8	37.2	865.0	100
1975[1]	440.0	40.6	263.3	25.2	371.1	34.2	1045.0	100

[a] Includes forestry and fishing.
[b] Includes mining and quarrying, manufacturing, engineering and construction.
[c] Includes distribution, transport, communications and government.
[1] Provisional.

Source: Bank of Guyana Annual Report (1975).

by the fact that a large part of output in the industrial and service sectors are directly related to enhancing or fostering agricultural output. The contribution of agriculture to domestic product declined steadily from approximately 30% in 1965 to about 22% in 1973, then it jumped sharply to 41% in 1975. The latter increase is to be attributed principally to increased commodity prices in 1974-75, especially for sugar which increased in price three times between 1973 and 1974. Sugar alone accounts for approximately 40% of the value added in agriculture, hence price increases of this magnitude will be reflected in major increases in total agricultural output. This fact is also highlighted by the observation in Table 3 that in the 1974-75 period, the overall physical level of sugar output remained constant relative to the 1972 level of output.

The real significance of these figures for the Guyanese economy is that the economic base is so narrow that changes in the levels of price and output for a few commodities can cause very significant changes to the level of total output in the economy. While most of the other sectors stagnated, or grew only modestly in the 1974-75 period, the changes in commodity prices were largely instrumental for the increase in GDP by 88% from 1973 to 1975. Preliminary indications are that the swing in prices back to their pre-1973 level has caused an equally great contraction in the value of total output in the 1976-77 period. Exacerbating the change in price levels, is the instability in weather patterns, which must take some measure of blame for the extremely volatile

Table 3

Indicies of Physical Output of Selected Commodities - Annual Rates: 1972 = 100

Commodities	Unit (000)	Physical Output in 1972	1972 Weights	1966	1970	1971	1972	1973	1974[1]	1975[1]
Sugar	Tons	315	46.7	91.7	98.7	117.1	100	84.1	108.2	95.2
Rice	Tons	94	11.6	170.2	151.1	127.7	100	117.0	152.1	170.2
Meat[2]	Lbs.	23,958	13.4	56.7	79.0	90.4	100	105.9	97.5	132.2
Timber[3]	Cubic ft.	6,000	1.6	150.2	107.0	92.0	100	108.2	146.8	149.7
All Agriculture			100.0	90.3	100.1	109.7	100.0	96.3	108.8	110.3
Bauxite: Dried	Tons	1,652	23.2	96.6	138.6	127.4	100	100.7	83.0	80.0
Bauxite: Calcined	Tons	690	52.7	73.0	100.4	93.3	100	92.3	105.2	112.6
Bauxite: Alumina	Tons	257	21.0	111.7	121.4	116.0	100	91.1	121.0	114.4
Bauxite: Other	Tons	32	1.3				100.0	146.3	96.9	81.3
Manganese[4]	Tons	97		185.5						
Gold	Ozs	39	0.2	76.9	112.8	35.9	100	194.9	312.8	464.1
Diamond	Carat	47	1.6	210.6	131.9	102.1	100	112.8	63.8	44.7
All Mining			100.0	89.0	114.4	111.8	100.0	95.2	102.9	104.6
All Manufacture	Lbs.		100.0	73.5	81.4	92.7	100.0	107.3	123.3	119.9

[1] Provisional; [2] Output of Commercial Producers Only; [3] Excludes Wallaba Poles;

[4] 1968 = 100; Physical Output in 1968 when mines closed.

Source: Bank of Guyana Annual Report (1975).

physical outputs noted in Table 3. Significantly in 1977, labour unrest was adding to the ills that plague Guyanese agriculture. Hope (1976) and numerous critics of the government's handling of agriculture, would also hold the government culpable with respect to adequacy of policy and production techniques.

The industrial sector has experienced a modest but steady increase from the 1965 levels to the present. As constituted in Table 2, it includes mining, manufacturing, engineering and construction. On average, it accounts for about 30% of GDP, and is overwhelmingly dominated by the mining industry which contributes approximately 15% of GDP. The principal output is bauxite and related products which account for over 90% of the total output of the mining and quarrying industry. Table 3 reveals that the physical output of dried metal-grade bauxite is actually decreasing in favour of calcined bauxite and alumina production. This reflects a conscious policy decision of the state-owned company, Guymine, to capture as much of the value added in the increased processing of alumina and calcined bauxite for which Guyana is the world's largest supplier, and for which product the existing Guyanese deposits are particularly well suited. Capacity expansion in calcined bauxite production in 1975 has increased significantly the company's capabilities in this product, and its current 64% contribution to company sales revenues should increase accordingly. Alumina contributes 36% of sales revenues, and should the proposed smelter agreements with Jamaica and Trinidad materialize, coupled with the success of Guyana's own attempts at hydro-power development, then a significant future awaits the dried metal-grade, bauxite and alumina facilities, which would be feeders to the proposed smelter. Gold, diamond, and quarrying which represent the currently unorganized components of the mining industry will be dealt with at length in a subsequent section.

EXPENDITURE, SAVINGS AND DEBT

Approximately 65% of the expenditure on the domestic product is accounted for by private consumption, and this proportion has been relatively constant in the 1960-73 period (see Table 4). However, it decreased to about 54% in the 1974-75 period on account of the large export gains made by the sugar industry in that period. Government expenditure has increased from 12% to 25% of GDP, reflecting the greater involvement of government in economic activity. The level of gross domestic fixed capital formation averages about 24% of GDP during the 1961-73 period.

Capital formation in Guyana has been relatively erratic over the years. As displayed in Table 5a, capital consumption allowances represent the least volatile of the components and while it has increased absolutely in the 1965-74 period, it has generally showed a declining influence on the level of total domestic capital formation, to which it contributes approximately 25%.

Savings of households represent about 26% of total capital formation, 6% of GDP and approximately 8% of total personal income (Tables 5a and 5b) in the 1971-75 period. In absolute terms, savings of households has increased significantly over the period, though relative to total capital

Table 4

Expenditure on Domestic Product (G$000)

Item	1961	1965	1970	1971	1972	1973	1974
Private Consumption Expenditure	209,277	235,920	322,041	336,000	363,100	418,564	512,545
General Government Expenditure on Goods and Services	37,952	54,446	90,938	101,653	116,901	159,666	162,239
Gross Domestic Fixed Capital Formation	77,432	70,037	112,640	102,800	108,300	154,783	198,083
Change in Stock	-1,015	10,592	9,223	2,300	10,624	20,717	54,011
Exports of Goods and Non-factor Services	164,267	200,263	302,367	329,446	344,358	336,479	659,500
Less Imports of Goods and Non-factor Services	169,367	208,955	305,368	308,496	352,141	444,264	630,000
Statistical Discrepancy	--	--	3,709	415	8,141	-1,148	-1,592
EXPENDITURE ON GROSS DOMESTIC PRODUCTS	318,546	362,303	535,550	564,118	599,283	644,797	954,780

Source: Government of Guyana Annual Statistical Abstract (1974).

Table 5(a)

Gross Domestic Capital Formation

(Thousands of Guyana Dollars)

ITEM	1965	1970	1971	1972	1973	1974
Capital Consumption allowances	18,787	33,785	33,371	33,368	35,948	39,976
Savings of Resident Corporation	9,352	6,839	13,407	15,537	4,313	24,906
Saving of General Government	-5,662	21,445	15,839	10,070	-44,598	132,874
Savings of Households	22,502	18,118	27,561	37,121	40,758	24,937
Net Investment from Abroad	35,650	45,385	15,937	30,969	137,931	27,809
Statistical Discrepancy	---	-3,709	-415	-8,141	1,148	1,592
FINANCE OF GROSS DOMESTIC CAPITAL FORMATION	80,629	121,865	105,100	118,924	175,500	252,094

Source: Government of Guyana, Annual Statistical Abstract (1974).

Table 5(b)

Expenditure and Saving From Personal Income ($000G)

	1971	1972	1973	1974	1975
Private Consumption Expenditure	336,000	363,100	418,564	512,545	562,469
Direct Taxes[a]	32,922	34,783	38,458	50,218	57,400
Other Non-tax Payments to Government[b]	3,022	3,230	3,214	2,979	5,413
Total Current Expenditure	372,744	401,113	460,236	565,742	623,282
Saving	28,695	37,121	40,758	24,937	73,116
TOTAL INCOME	401,439	438,234	500,994	590,679	698,398

[a] Includes Employer and Employee contribution

[b] Payment of fees in Public Institutions, court fines, etc.

Sources: Government of Guyana: Quarterly Statistical Digest (1976), Annual Statistical Abstract (1974).

formation and income, it has been basically constant. With low per capita income levels as in 1975 when it was just under G $1000, it is not surprising that private consumption accounted for approximately 84% of income. The ability of the government to induce people to reduce consumption below these levels will indeed be very doubtful, hence throwing a distinct restriction on the government's ability to foster capital formation through increased savings of households.

Savings of resident corporations and government have increased significantly from the 1950's when it was about 2% of GDP to about 7% in 1972 (Hope 1976). The dissaving noted in 1973 is largely explained by the phenomenal import fuel bill caused by the oil price increases at that time. The public sector has been charged with the responsibility for generation of a major part of the domestic savings which will be required for internal development, and given the already high level of tax effort which Hope (1977) described as being operative in Guyana, the conclusion is inescapable that greater levels of surplus creation must be forthcoming from the government and its parastatal organs.

In 1973, taxes constituted about 87% of total government revenue, and 23% of GNP, with company taxes representing the major direct tax item. However, indirect taxes (mainly import and excise duties) account for 53% of total revenue, while direct taxes have increased sharply from 25% in 1969 to 46% of total tax revenues in 1973 (Hope 1977). The increased tax levels of the post-1965 period is indicated by the fact that from 1966 to 1975, revenue, of which taxation is the major component, increased from 25% to 45% of GDP. Hope's findings, that revenue shares were more closely related to per capita income levels than openness of the economy, clearly indicate that a central focus of government policy in revenue maximization would be to increase per capita income levels.

Investment from abroad has always been a significant element in domestic capital formation, and as can be seen in Table 5a, it softened significantly the blow of the oil price increases in 1973. External finance primarily comes from the United States, United Kingdom, Canada, the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). The increasing reliance of government on external and internal borrowing is indicated by the fact that debt charges have increased from 8% of current expenditure in 1966 to 25% in 1976 (Table 6). Of a total debt in 1974 of G $689 million, 60% was external, with the UK providing 19% and 11% of the external and total debt respectively, while the United States provided 26% and 16% respectively. The long term public debt in 1974 stood at G $689 million, representing 80% of GDP, having climbed steadily from 1960 when it was 37% of GDP. Guyana has been able to service its debt adequately up to the present, but as the absolute value of the debt increases to high proportions of current and capital expenditures, debt servicing may not be a simple problem unless productive surplus is generated in the economy.

Social services, particularly education and health, accounted for the lion's share of central government current

Table 6

Central Government Current Expenditure (1966-1976)

(Thousands of Guyana Dollars)

Year	Total	General[1] Administration	Social Services	Economic[2] Development	Debt Charges	Others
1966	84,154	23,044	29,246	11,816	12,989	7,057
1967	87,904	22,085	31,680	12,041	14,141	8,125
1968	98,208	24,054	34,088	13,613	17,874	8,378
1969	106,882	29,883	35,501	15,735	16,578	8,585
1970	122,723	38,753	39,194	18,056	17,595	12,125
1971	134,034	35,729	43,082	28,230	18,349	9,684
1972	160,435	40,305	47,492	34,714	25,125	12,799
1973	211,462	54,374	60,530	31,896	47,641	17,018
1974	254,703	72,864	74,130	38,386	56,707	12,616
1975	347,390	109,407	88,380	68,482	72,950	8,171
1976[a]	402,100	99,134	107,361	83,219	100,750	11,636

[a] Estimate
[1] Includes Law and Order
[2] Includes Public Works and Agriculture.

Sources: Government of Guyana: Annual Statistical Abstract (1974), Quarterly Review of Financial Statistics (1978).

expenditures, and this has resulted in a population which is over 90% literate, and which has seen significant increases in life expectancy, and decreases in infant mortality. However, in Table 6, its share in total current expenditure has decreased from 35% in 1966 to 27% in 1976, while that of economic development has increased from 14% to 21% in the 1966-76 period, and as seen above, similar increases were made by debt charges. General administration of the government machinery inclusive of law and order, accounted for approximately 26% of current expenditure and has only shown slight variations over the same period. The inescapable point is made that even though total current expenditure has quadrupled in the 1966-76 period, a larger part of the increase is being siphoned off to service debt and to a lesser extent fostering economic development, while the social sector receives less of the absolute increases through time.

In the case of capital expenditures which approximates 31% of total government expenditures in the 1966-76 period, the economic sector has received the largest contributions (Table 8). This sector has received a relatively constant porportion of the capital expenditures as seen in Table 7, where it approximates 89% in the 1966-76 period. However, very significant changes occurred in the relative participation of the individual components of this sector. Most notable is the phenomenal increase in expenditure on central government which in the 1972-76 period, jumped from G$9.4 million to G $107.6 million (i.e. 17% and 41% of total capital expenditures respectively). This tremendous increase

Table 7

Central Government Capital Expenditure (1966-1976)

(Millions of Guyana Dollars and Percentages)

Year	Social[1] Sector	%	Economic[2] Sector	%	Total	%
1966	3.5	11.0	28.4	89.0	31.9	100
1967	4.6	13.6	29.2	86.4	33.8	100
1968	3.5	8.8	36.2	91.2	39.7	100
1969	6.9	14.3	41.3	85.7	48.2	100
1970	5.8	11.1	46.3	88.9	52.1	100
1971	2.4	4.3	53.4	95.7	55.8	100
1972	4.5	8.7	51.9	91.3	56.4	100
1973	9.4	11.3	73.9	88.7	83.3	100
1974	11.7	11.3	92.1	88.7	103.9	100
1975	20.7	8.2	234.4	91.9	255.1	100
1976	24.7	9.4	237.2	90.6	261.8	100

[1] Includes education, health, housing and others.
[2] Includes lands, mines, forests, transport, communications, public administration, and finance.

Sources: Government of Guyana: Quarterly Review of Financial Statistics (1976, 1972).
Hope (1976).

Table 8

Central Government Total Expenditure (1966-1976)

(Millions of Guyana Dollars and Percentages)

Year	Current Expenditure	%	Capital Expenditure	%	Total Expenditure	%
1966	84,154	73	31.9	27	116.1	100
1967	87,904	72	33.8	28	121.7	100
1968	98,208	71	39.7	29	137.9	100
1969	106,882	69	48.2	31	155.1	100
1970	122,723	70	52.1	30	174.8	100
1971	134,034	71	55.8	29	189.8	100
1972	160,435	74	56.4	26	216.8	100
1973	211,462	72	83.3	28	294.7	100
1974	254,703	71	103.9	29	358.6	100
1975	347,390	58	255.1	42	602.5	100
1976	402,100	61	261.8	39	664.0	100

Source: Tables 6 and 7.

has occurred at the expense of most of the other components except transport and communications which showed a modest absolute and relative increase. Hope (1973) refers to this phenomenon of increasing government presence as "the greatest structural change occurring in the economy during the post-war period". The public presence manifests itself in the creation of at least 28 public corporations which are directly engaged in specialized forms of economic activity (see Appendix 2), and the nationalized sugar and bauxite industries.

BALANCE OF PAYMENTS AND TRADE

In the section on debt and current government expenditures, reference was made to the importance of capital inflows from abroad. In Table 9, this importance is underlined by the observation that except for the years 1962-63, Guyana has consistently been experiencing a negative balance on goods and services traded. Capital inflows performed the very useful function of bolstering this net drain on the country's reserves, and were particularly significant in 1973 when the fuel import bill increased significantly. It should be mentioned that in the 1974-75 period, the deficits on the current account were largely due to deficits in the services sector where payments for a variety of professional and business services increased to approximately G $70 million - about 7% of GNP at factor cost, thus offsetting the surplus generated in the Merchandise trade. These persistent deficits have necessitated the institution of rather rigid foreign exchange controls.

Table 9

Balance of Payments, 1962-1976

(Millions of Guyana Dollars)

G$Mn	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975[1]	1976[5]
Imports[2] (-)	189	170	211	243	270	289	292	319	350	346	367	457	660	936	927
Exports[2] (+)	192	196	194	206	220	244	267	295	304	333	344	333	650	908	685
Balance on Goods & Services	+ 3	+26	-17	-37	-50	-45	-25	-24	-46	-13	-23	-124	-10	-28	-242
Net Capital Inflows[3]	+ 8	-13	+25	+24	+38	+59	+23	+15	+43	+25	+43	+81	+80	+118	--
Decrease (+) or Increase (-) in reserves[4]	-11	-13	- 8	+13	+12	-14	+ 2	+ 9	+ 3	-12	-20	+43	-70	-90	--

[1] Preliminary estimates.
[2] Goods and services, including factor services.
[3] Including grants.
[4] Changes in net foreign assets of banking system.
[5] Merchandise trade alone (provisional).

Sources: Hope (1975), Bank of Guyana Annual Report (1975), Government of Guyana, Quarterly Statistical Digest (1976).

The predominance of agricultural and mineral products in the export sector is shown in Table 10 by the fact that these two sectors account for over 92% of total exports. Even within these sectors, there is a high degree of concentration, as sugar accounts for over 75% of total agricultural products while bauxite and bauxite products account for over 97% of total mineral exports. Traditionally, up to the mid-1960's, sugar was the major export earner, but its dominance was overtaken by bauxite and alumina exports in later years (see Table 11). Though total export earnings increased three times from 1967 to 1975, Table 11 reveals that ~~the major~~ increase is due to increased earnings resulting from trebling of sugar values in 1974-75 on account of a similar increase in prices rather than increases in quantity. In fact, of the major export products listed in Table 11, only rice showed any significant increases in physical output in the 1974-75 period, while the output of sugar even declined primarily on account of labour unrest.

The inescapable fact is that the export sector around which the entire Guyanese economy is built has stagnated in terms of physical output and had it not been for an unprecedented and transitory positive terms of trade advantage for sugar, rice and bauxite products, in 1974-75, the entire economy would have been tremendously depressed. The indications for the 1976-78 period, in which the terms of trade has turned, are that the export sector has stagnated, the balance of payments has deteriorated, and the foreign reserves are at an all-time low. The resulting effect on domestic

Table 10

Sectoral Origin of Exports and Imports

(Millions of Guyana Dollars)

	Exports					Imports			
Period	Total Exports	Agriculture	Forest	Mineral	Manufacture	Total Imports	Consumer Goods	Intermediate Goods	Capital Goods
1967	211.7	101.2	2.7	93.5	8.7	---	---	---	---
1968	229.0	107.1	2.8	108.1	4.2	212.9	80.8	66.3	65.8
1969	252.9	111.3	2.5	124.1	6.6	234.4	91.9	72.0	70.5
1970	264.8	105.4	3.4	138.9	7.7	266.3	92.6	77.1	96.6
1971	290.9	127.1	7.3	137.3	8.0	266.0	102.6	84.7	78.7
1972	299.9	142.6	5.0	134.5	11.2	297.9	107.1	100.7	90.1
1973	288.0	120.4	5.7	141.7	14.1	372.5	121.6	144.0	106.9
1974[1]	600.0	367.8	6.6	200.3	17.3	565.0	106.7	314.2	144.1
1975[1]	849.5	537.0	9.9	266.7	18.4	806.4	130.0	411.5	264.9

[1] Provisional

Source: Bank of Guyana Annual Report (1975).

Table 11

Value of Principal Exports, 1956-76

(Millions of Guyana Dollars)

Year	Sugar	Rice	Bauxite	Alumina	Diamonds	Rum	Timber	Molasses
1956	43.6	9.9	29.3	--	1.3	3.8	3.2	1.0
1957	53.6	9.2	29.5	--	1.4	4.0	3.5	2.2
1958	54.7	4.8	20.5	--	1.4	3.5	3.6	2.6
1959	46.4	12.5	25.0	--	3.0	3.5	3.3	2.3
1960	57.5	15.4	29.5	--	4.8	3.0	3.5	2.7
1961	56.8	22.6	28.5	12.1	5.1	3.1	3.0	2.7
1962	59.3	20.5	31.1	22.7	3.7	3.2	3.0	3.0
1963	73.6	20.1	28.6	22.3	3.6	3.1	2.6	5.7
1964	53.9	21.8	30.2	26.7	4.5	3.3	2.6	4.4
1965	44.5	23.0	37.4	30.3	5.6	4.3	3.1	2.1
1966	48.5	24.9	44.6	33.0	5.1	3.4	3.6	2.8
1967	54.6	25.2	45.6	31.4	6.2	5.7	2.7	4.7
1968	59.3	26.1	58.2	33.1	4.7	4.2	2.8	4.3
1969	82.4	19.7	62.6	38.9	3.8	2.9	2.5	4.3
1970	72.5	18.3	92.2	46.4	3.4	3.2	2.4	3.8
1971	92.2	21.3	96.0	40.5	2.5	6.6	6.5	4.0
1972	101.8	25.3	103.3	28.3	2.3	5.6	3.5	3.3
1973	75.9	25.0	108.1	26.9	3.1	7.4	4.6	3.3
1974	284.8	49.0	153.4	47.6	1.8	11.4	5.4	9.9
1975	413.1	84.8	197.6	65.3	1.2	16.7	8.5	5.6
1976	233.5	73.6	229.0	61.2	0.8	12.9	9.7	6.0

Sources: Government of Guyana, Quarterly Statistical Digest (1976), Annual Statistical Abstract (1975), External Trade Report (1972).

spending is for an overall contraction, with the modest levels of service and consumption to which the Guyanese public had become accustomed, being seriously curtailed.

Prior to 1973, consumer goods formed the largest single component of total imports. It accounted for approximately 36%, with intermediate and capital goods sharing approximately equally in the rest of the total imports. However, as seen in Table 10, importation of intermediate and capital goods increased significantly in the post-1973 period. The high import bill for intermediate goods to a large extent reflects the increased prices for petroleum and petroleum products, while the capital goods increases are due principally to machinery and transport equipment connected with hydropower development. The poor performance of the export section in the 1976-78 period has resulted in reduced capital and intermediate goods imports, with the result that a lot of the equipment purchased in the 1974-75 period, now lies idle. The ability of the economy to meet the capital and intermediate goods requirements of an ambitious development programme has been seriously questioned by Hope, David and Armstrong (1976) and by many commentators; and these figures would indicate that their skepticism is not misplaced, if the structural form of the economy remains unchanged.

The destination of Guyana's exports reflects to a large extent, the organic connection between primary production in Guyana and secondary production and consumption in the developed world. As depicted in Table 12, the United Kingdom, the former colonial master, continues to be the dominant

Table 12

Direction of Guyana's Foreign Trade

(Millions of Guyana Dollars)

Period	Category	Total[1]	Sterling Area				Dollar Area				Rest the World
			Total	U.K.	C.C.C.	Other	Total	U.S.A.	Canada	Other	
1968	Exports	229.0	81.1	44.6	31.3	5.2	109.4	56.1	50.3	3.0	38.5
1969	"	252.9	95.2	63.3	30.1	1.8	114.0	60.0	49.7	4.3	43.7
1970	"	264.8	89.8	49.9	38.6	1.3	129.5	62.9	57.0	9.6	45.5
1971	"	290.9	112.1	63.6	47.0	1.5	123.5	69.2	42.3	12.0	55.1
1972	"	300.0	156.9	93.3	62.0	1.6	81.2	63.9	8.4	8.9	61.9
1973	"	288.1	143.2	86.4	56.7	0.1	77.6	48.4	12.2	17.0	67.3
1974	"	600.0	211.8	124.3	86.4	1.2	207.5	150.4	27.4	29.5	180.7
1975[2]	"	850.0	366.7	252.4	119.9	4.4	238.1	191.7	27.5	18.9	245.2
1976	"	684.8	—	183.0	110.1	—	—	134.0	18.7	—	—
1968	Imports	212.9	107.1	64.4	29.6	13.1	66.8	44.4	20.1	2.3	39.0
1969	"	234.4	120.8	74.6	32.6	13.6	71.2	48.7	19.5	3.0	42.4
1970	"	266.3	131.8	83.1	37.7	11.0	88.7	61.1	24.5	3.1	45.8
1971	"	266.0	134.6	82.0	41.3	11.3	90.3	66.7	17.0	6.6	41.1
1972	"	297.9	154.5	90.5	51.3	12.7	90.1	72.3	15.2	2.6	53.3
1973	"	372.5	189.3	94.7	82.5	12.1	114.8	90.2	19.8	4.8	58.4
1974	"	565.0	279.8	116.2	148.9	14.7	182.4	146.1	28.0	8.3	102.8
1975[2]	"	806.0	362.7	173.9	172.8	16.0	294.3	237.7	35.1	21.5	149.0
1976	"	927.4	—	213.4	208.3	—	—	263.9	33.7	—	—
1968	Trade Balance	+16.1	-26.0	-19.8	+1.7	-7.9	+42.6	+11.7	+30.2	+0.7	-0.5
1969	"	+18.5	-25.6	-11.3	-2.5	-11.8	+42.8	+11.3	+30.2	+1.3	+1.5
1970	"	-1.5	-42.0	-33.2	+0.9	-9.7	+40.8	+1.8	+32.5	+6.5	-0.3
1971	"	+24.9	-22.5	-18.4	+5.7	-9.8	+33.2	+2.5	+25.3	+5.4	+14.2
1972	"	+20.1	+2.4	-2.8	+10.7	-11.1	-8.9	-8.4	-6.8	+6.3	+8.6
1973	"	-84.4	-46.1	-8.3	-25.8	-12.0	-37.2	-41.8	-7.6	+12.2	-1.1
1974	"	+35.0	-68.0	+8.1	-62.5	-13.5	+25.1	+4.3	-0.6	+21.2	+77.9
1975[2]	"	+44.0	+4.0	+78.5	-52.9	-11.6	-56.2	-46.0	-7.6	-2.6	+96.2
1976	"	-242.6	—	-30.4	-98.2	—	—	-129.9	-20.0	—	—

[1] Includes personal effects of migrants.

[2] Provisional.

C.C.C. - Caribbean Commonwealth Countries.

Source: Bank of Guyana Annual Report (1975);
Quarterly Statistical Digest (1976).

destination for Guyana's exports (27%), in particular sugar, which was the backbone of the colonial economy in Guyana. Next in importance is the United States (20%), which buys significant amounts of sugar and bauxite products. The majority of the exports to the Caribbean Commonwealth Countries (CCC) is represented by rice, while Canada principally buys bauxite and alumina.

The United States has taken over from the United Kingdom as the principal supplier of Guyana's imports in the post-1973 period. This reflects in large part, the increased importation of capital equipment from the United States in that period. When combined with a shift in the destination of a part of Guyana's bauxite products away from the U.S. market, this has led to persistant trade deficit with that country from 1971 except for a small surplus in 1974. A similar reason would explain the trade deficit with Canada. There seemingly has always been (except for anomalous years like 1974 and 1975) a trade deficit with the United Kingdom which traditionally has been Guyana's major trading partner, until the recent U.S. dominance. Imports of consumer and capital goods have traditionally originated from the U.K. and it continues to be a major supplier.

On July 4, 1973, Guyana became a member of the Caribbean Economic Community (CARICOM), within which free trade exists, and around which common tariff barriers were created for goods originating outside of the area. Table 12 shows quite clearly that Guyana's trade balance with its community partners has been in deficit since 1973. This deficit is primarily held with Trinidad and Tobago, from which Guyana receives 85% of its imports originating in the region. The major part of these imports is for fuel which quadrupled in price in 1973, along with minor amounts of fertilizers, cement and consumer durables. Guyana's principal export to the region is rice, for which Trinidad is the major buyer (42%), followed by Jamaica (37%) in 1976. Guyana's imports from CARICOM countries increased five times as fast as its total imports from 1968 to 1972, and whether it can take advantage of the increased market size formed by the creation of the Community agreement is largely a function of the internal organization of the productive elements in the Guyanese economy to make Guyanese products acceptable and competitive. Trinidad and Tobago and Jamaica have showed that the industrial headstart which they possessed has created tremendous benefits in the enlarged community.

PRICE LEVEL AND WAGES

The 1970's in Guyana was marked by increased price levels as the period 1970-76 saw an average annual increase in prices of 10.3%, compared to just under 2% for the 1960-70 period. The major escalation in consumer prices occurred in the 1973-74 period when the price index increased by 20 percentage points, primarily reflecting the readjustments of the local economy to higher levels of world prices coupled with the dramatic escalation of world oil prices. The major increase in prices occurred in the food and clothing industry which experienced increases averaging 14.5% per year in the 1970-76 period, while the housing industry experienced only slight movements with an average of 2.5% (see Table 13). Regionally, the rural communities had to face higher prices than the urban areas, especially for clothing and housing. However, food prices in the rural districts were marginally lower than in the urban centres.

The data depicted in Table 14 on earnings and hours worked for the 1973-76 period, indicate that the bauxite industry pays wages that are completely out of step with the rest of the economy. An earlier comprehensive study by Brewster (1969), showed that the pre-1950 period was characterized by a general uniformity of wage rates, but that by 1962, significant divergences between the bauxite and non-bauxite workers occurred. This trend seems to have continued to 1973, with significant gains being made by the services sector which was growing faster than the industrial or agricultural sectors. However, increased militancy of union activity in the sugar industry has resulted in significant gains to the sugar worker, who increased his hourly earnings by 55% from 1973 to 1976. The wage rate in other sectors has grown much slower, and up to 1976, the duality of incomes persists between the bauxite and non-bauxite sectors. One must, however, recall that the bauxite industry employs less than 4% of the labour force, and it does represent one of the most productive areas in the economy, hence the high wage represented here cannot be considered as reflective of productivity levels in the rest of the economy.

Table 13

Consumer Price Index

(1970 = 100)

Period	All Items Index	All Items Index (Rural)	All Items Index (Urban)	Sub-Group Indices			
				Food Beverages & Tobacco	Clothing	Housing	Miscellaneous
1960[a]	80.2	---	80.2	77.7	85.2	87.1	81.3
1965[a]	88.1	---	88.1	87.1	87.0	91.4	90.0
1970	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1971	101.7	102.0	101.0	101.9	105.4	100.6	100.4
1972	106.7	106.8	106.0	109.5	110.3	100.8	104.4
1973	117.2	118.0	114.0	123.7	128.8	101.8	111.7
1974	140.3	142.3	134.0	157.4	154.1	110.1	122.0
1975	148.7	150.2	144.6	166.7	172.4	113.5	128.9
1976	161.7	162.9	157.6	187.2	186.7	114.9	135.1

[a] 1960 and 1965 figures are for the Urban index alone.

[b] Includes rent, fuel and light.

Sources: Government of Guyana, Quarterly Statistical Digest (1976); Bank of Guyana Annual Report (1975).

Table 14

Annual Data on Earnings and Man-Hours Worked

Sector	1973		1974		1975		1976	
	Avg. Man Hrs.Wkd. per week	Avg. hourly Earnings per Operator $ ¢	Avg. Man Hrs.Wkd. per week	Avg. hourly Earnings per Operator $ ¢	Avg. Man Hrs. Wkd. per week	Avg. hourly Earnings per Operator $ ¢	Avg. Man Hrs.Wkd. per week	Avg. hourly Earnings per Operator $ ¢
Sugar	36.3	.99	38.2	1.07	37.7	1.23	38.9	1.53
Field	33.7	1.01	35.7	1.10	35.0	1.31	36.1	1.59
Factory	48.6	.92	52.4	.96	51.0	1.13	53.4	1.31
Food, Beverages and Tobacco	42.3	.93	42.9	1.02	43.6	1.10	44.9	1.15
Other Manufacturing	46.5	.83	46.9	0.98	48.2	1.05	47.4	1.13
Mining and Quarrying	40.1	2.18	43.6	2.21	43.3	2.16	48.0	2.33
Bauxite	40.1	2.21	43.1	2.28	43.3	2.36	48.0	2.36
Other	38.2	1.14	55.0	0.93	39.7	.92	47.8	1.21
Services	43.3	1.30	48.1	1.22	46.3	1.31	46.1	1.44
Districution	—	—	42.4	0.89	41.4	.95	42.5	1.03

Source: Government of Guyana, Quarterly Statistical Digest (1976).

THE DEVELOPMENT PROSPECTS

The preceeding sections presented a factual account of the state of the Guyanese economy without any comments as to their significance in a development framework. Briefly summarized, Guyana was described as a country in which there was:

(i) An uneven population density distribution, with over 90% of the population living on a relatively overcrowded coastal strip, while 85% of the country is only partially known, and relatively uninhabited.

(ii) An extremely high rate of unemployment and under-employment, particularly among the youth.

(iii) A scarcity of capital that is exacerbated by very low rates of domestic accumulation due to small average per capita income levels.

(iv) A potentially unstable socio-political environment caused by racial division.

(v) A dominance of agriculture which is primarily concerned with sugar and to a lesser extent rice.

(vi) A large measure of production for self-consumption.

(vii) A deficiency of technical knowledge.

(viii) A large primary narrowly-based export sector which displayed extreme income fluctuations.

(ix) A low ratio of industrial output and employment to total output and employment.

(x) A relatively open economy with a high import content of consumption and capital goods.

(xi) A trade pattern which reflects to a large degree the pre-colonial organic connection between Guyana and a few large metropolitan centres.

(xii) A very low absorptive capacity for capital (David 1969, Hope and David 1974), and an escalating national debt.

Given the above characteristics, it becomes very simple to categorize Guyana as an underdeveloped country whether underdevelopment is defined as "...a failure to provide acceptable levels of living to a large proportion of a country's population, with resulting misery and material deprivation" (Kuznets 1954), or as a country which "has good potential prospects for using more capital or more labour or more available natural resources, or all of these, to support its present population on a higher level of income, or, if its per capita income level is already fairly high, to support a larger population on a not lower level of living" (Viner 1953), or as a country in which Myint (1953) identifies "underdeveloped resources"....and "backward people"....the latter meaning people who are "unsuccessful in the economic struggle to earn a livelihood". In Myint's schema, they are distinct phenomena which may or may not coexist, but when they do, they "aggravate each other in a vicious circle whose historical dynamic cannot be simply treated within the framework of optimum resource allocation suggested by the underdevelopment approach".

It is equally precise to categorize Guyana in terms of Rostow's (1956) 'enclave economy', which even though it manifests relatively high levels of savings and investment, does not have self-sustained growth because the institutional, social, and political framework might not be consistent with development. The enclave type of economy is essentially export-oriented and typically does not have a significant manufacturing sector which Rostow sees as being crucial to self-sustained growth.

With these conceptions of underdevelopment, the fifties and sixties were invaded by a plethora of "development theorists", each with their own brand of solution for the ills of underdevelopment. Notable among that era of development theorists, was Schumpter (1949) who defined development as "such changes in economic life as are not forced upon it from without but arise by its own initiative from within." However, Schumpter's internal generating force was the entrepreneur, who used the process of innovation to achieve a goal of private profit. These forces, process and goal worked well for the developed countries (DC) in their transition, but are highly questionable in their relevance to the contemporary UDC as their socio-political environment, coupled with their historical development are very different. Quite intuitively Wallich (1952) identified government as the major force, political pressure as the process, and a higher standard of living as the goal that are operative in an underdeveloped country. While development in the UDC can be considered as derived (because of its emphasis on consumption), that of the DC is rooted in notions of acquisitiveness and is of an originating nature (emphasis on production). Derived development has traditionally met obstacles in its later stages because of the lack of savings and other productive factors, and has logically been accompanied by the increasing presence of government which hopefully provides the necessary organizing ability, the incentives for inducing savings, and the creation of the social overhead, which are necessary for development to occur. This, in part, explains the growing presence of government in the Guyanese economy.

Other notable works are those of Hirschman and Lewis (1954), who stress the need for promotion of the capitalist sector in surplus labour economies because it is that sector which is the major source of the savings required to foster development. In this scheme, the dynamic economies of "learning by doing", coupled with the exposure of the subsistence sector to newer and better methods of production, and the trickling down of the proceeds of development from the Malthusian "enclaves of economic privilege", were responsible for bringing the subsistence sectors along. It should be pointed out, however, that Lewis' capitalist sector could be private or the state, and he does recognize that the latter may be just as equipped to perform the necessary capital accumulation. This will supposedly induce a decrease in the ranks of the unemployed in the capitalist, and traditional sectors, where the lateral and vertical growth of an imitative nature in the latter accompanies expansion and greater labour absorption in the former.

Contrary to the views of Lewis and the proponents of development by "leading sectors", are a group of economic theorists who view the principal constraint to development in the UDC as the fact that external economies to productive activity are lost to the system, instead of being internalized. Of this group, Nurkse (1958) formalized the arguments for what is now considered as the phenomenon of "balanced growth". In this approach, the central focus in the industrialization process is the development of a range of industries that are complementary in a vertical as well as a lateral sense, as the economies so captured, might make individual uneconomic enterprises, economic within a collective programme. Rosenstein-Rodan's (1943) "big-push" theory viewed the problem from the side of productive efficiency where the economies generated due to growth within the industry and the growth of other industries can be captured. Nurkse's approach derives from the side of demand as was neatly captured in his proposition that "the case for balanced growth rests ultimately on the need for a balanced diet." He emphasized the fact that the small size of the market, coupled with the inability of supply to create its own demand, leaves no recourse to development except through balanced growth in a wide range of consumables, which accord with consumers' preferences and create its own demand. The principal difficulty of these two approaches is that they assume an unlimited supply of capital and other resources which characteristically are absent in Guyana and the average UDC. Secondly as Demas (1965) pointed out, small markets characteristically cannot reap the full economies associated with large scale production in manufacturing, nor the economies associated with administration.

Prebisch (1949), Pinto and Knakal (1973), Sunkel (1973), Girvan (1973), Brewster and Thomas (1967), and a budding group of Latin American and Caribbean economists have been increasingly concerned with the phenomenon of dependent underdevelopment which is prevalent in Guyana and other UDC's. This phenomenon manifests itself in (a) stagnation of agriculture with increasing food imports, (b) concentration of primary commodities in exports, (c) a large foreign exchange bill of industrialization which is exacerbated in some cases by foreign dominance, and (d) a growing fiscal debt. As depicted in the case of Guyana, the external debt, low availability of domestic finance, and an uncertain export sector have resulted in Guyana becoming increasingly inserted in the orbit of the industrialized centres, since it needs extensive credit facilities to meet basic levels of government servicing.

It must be immediately recognized that this dependence can take two forms as identified by McIntyre (1972). It could be either structural, or functional. The former is dependence which is a direct function of size and structure of the economy which cannot be helped, while the latter is due to conscious decisions with respect to the form, modus operandi, motivational and attitudinal norms as determined by socio-historical tradition, etc., and obviously can be avoided by alternative policies. Both of these are evident in Guyana, and have contributed to its general state of dependent-underdevelopment. Secondly, it has become obvious that the substitutive industrialization, and modernization of the industrial centres as advocated by Prebisch and Lewis respectively have been very unsuccessful in causing real development in Latin America and the Caribbean (Girvan 1973).

Economic dependence as defined by Brewster and Thomas (1967) who formalized the concept is "a lack of capacity to manipulate the operative elements of an economic system". It reflects a situation where "there is a wide and growing disparity between the structure of domestic demand and structure of domestic resource use". Implied in the concept is the notion that the growth elements are external factors, and the internal sectors of the economy are unadaptive. Myint (1953) recognized the importance of this phenomenon at an early stage as he alluded to the inability of backward countries to develop an interconnected production cycle through a properly functioning multiplier-accelerator mechanism, and its effect on secondary and tertiary rounds of output, employment, and growth in technical knowledge. Naturally, the inherent assumptions for the proper functioning of multiplier principle are an elastic supply of working capital, an elastic curve for manufactures, excess capacity in consumption goods industries and involuntary unemployment. Notably, only the latter is observed in underdeveloped countries regardless of their size.

The foregoing demonstrates that a large part of the development process was to be accomplished by industrialization, whether conceived as part of a process of balanced, or unbalanced growth, of leading, lagging or balancing sector, or of a process of import substitution. This clearly seems to be the trend observed in most economies, as demonstrated by Chenery (1960) who finds that industrialization is positively correlated with per capita income which is in turn correlated to the type of industry. Typically, he found the major source of growth was in industrial production, which was essentially of an import substitution nature especially in intermediate and capital goods, while import substitution in the consumption goods sector only contributed marginally to growth. Of specific importance is Chenery's finding that country size seemed unimportant for the development of services, agriculture, and for most consumer goods, but it was extremely important for machinery, transport equipment, and intermediate products, with large sizes favouring the latter. The pattern of development in Guyana certainly reflects emphasis on services, agriculture and consumer goods, as large amounts of public spending were seen to be deployed in these areas.

The concept of size as a determinant in economic activity has essentially been restricted to microeconomic considerations of market organization, and economies of scale. In a macro sense, it has essentially been restricted to the consequences of size on the direction and consequences of trade in a Heckscher-Ohlin framework, and to their ramifications for regional integration efforts on the part of different peoples for whatever reason. Very little attention has been placed explicitly on the size of the nation as a deterrent or stimulant to growth. Specifically, even less has been done on the effect of small nation size on the growth process, and it is on this score that the International Economic Association conference of 1957 was of tremendous significance. That conference, especially through the articulation of Svennilson (1960), established that the nation regardless of its size is an important economic concept, especially since national boundaries represent points of discontinuity whether natural (physical or social) or artificial (through deliberate policy). However, it was generally agreed that a nation that was rich in natural resources could afford to be smaller in terms of its population size than one which was not well endowed, without suffering from the problems of inadequate market size, and its deleterious effect on efficient production. This view was well advocated by Kuznets (1960) who recognized that small countries typically have a narrow economic base because small physical size by definition will infer the probability of a smaller natural resource base, a smaller market, and the possibility that comparative advantage in specialized areas will in all probability be translated into more intense concentration on those areas, at the expense of diversification elsewhere. Kuznet's statistical work led to the conclusion that smaller countries generally have a higher proportion of their national income generated by exports of a limited number of products, which help to support a very diversified range of imports as was seen in Guyana.

The general impression as summarized by Robinson (1960) was that large size was not a panacea for the solution of most of the ills that retard the development process. Many small countries, notably the Scandanavian countries, and Britain were able to overcome the constraints of small size and its negative effect on scale economies via the precarious avenue of exports, and other policy measures which provided them with the dynamic for sustained growth. The Conference recommended that the spirit of GATT be given expression in less restricted trade, and the possibility of setting up Customs Unions for the distinct advantages of larger size.

If structural changes were necessary for the larger underdeveloped economies as Myint suggested, and for the small countries (less than 10 million people) as Kuznets recommended, it was even more relevant for the economies of under five million people as Demas (1965) illustrated. Demas (1965) must be credited for elucidating some of the principal relationships that govern the modus operandi of small underdeveloped countries, especially those of the Caribbean. To Demas, "underdevelopment is the extent to which an economy has undergone structural transformation and has acquired the continuing capacity to adapt and to apply innovations". He insists that such a transformation is generally followed by an increase in real income per capita, but that the corrollary does not necessarily hold. This view of the transformation can be easily associated with the pronouncements of Dowd (1967), who considers that the concept of growth should be separated from that of development as "growth is a quantitative process involving principally the extension of an already established structure of production, whereas development suggests qualitative changes: the creation of new economic and non-economic structures." The gross figures say nothing of the structure, distribution, level of dependence of the economy on its various sectors, nor do they say anything about the future prospects of the various sectors, and the level of unemployment and underemployment.

The transformation of the production process as defined by Demas (1965) involves seven elements which are not necessarily exclusive. They are:

(i) a decrease in dualism economically, geographically, and socially

(ii) reduction of surplus labour and its replacement in more productive activities

(iii) creation of a national market for goods and services at the expense of the subsistence sector

(iv) increasing the contribution of the secondary and tertiary sectors to total output

(v) the fostering of greater inter-industry linkages and interdependence

(vi) decreasing the proportion of national income spent on imports and

(vii) the diversification of the economy.

No doubt, these seven elements are crucial to self-sustained growth which Rosenstein-Rodan (1961) distinguishes from sustained growth by the fact that the latter is usually associated with a significant foreign aid contribution, while the former connotes the idea of a development process that has its own internal dynamic.

These seven elements, negatively read, are what Demas considers as the principal characteristics of any small, narrowly-based, export economy such as Guyana and the rest of the Caribbean, and he stresses the fact that they are typically enclave types with satellitic relationships to the major metropolitan centres. This latter concern is perhaps what was foremost in the mind of Dowd (1967) who advocated that power is an essential tool for development as the rapid structural transformation that is necessary cannot be accomplished without the complete control of the reins of government which power provides. One recognizes, of course, that this is a necessary but not sufficient condition for development to occur.

Advocacy of structural reform does not imply that all sectors of the economy will be assigned new and immediate roles. Rather, it recognizes that some sectors of the economy especially the traditional export sector which is not merely a leading one, but the pivotal growth centre, will have to be strengthened so that the savings-investment and foreign exchange problems can be overcome. However, this forced openess or what McIntyre (1970) calls "structural openess" must be used more as a vehicle in transformation rather than as an immediate source of income for more consumption goods. Furthermore, as McIntyre argued, "functional openess" in terms of monetary and trade policies, subsidies, tariffs, quotas, preferences, etc., must be all concerned with aiding the internal rearrangements in production and the desired diversification.

Fundamentally, however, one must recognize that industrialization, or any form of development for that matter, will not occur, unless the climate is conducive for people to participate willingly in the economic process. By climate is meant the whole gamut of socio-economic institutions which reduces the level of risk-bearing by private individuals (if private sector development is to be fostered), and induces the feeling of commitment, responsibility and involvement of the masses (if public sector development is to predominate).

Diversification of the production structure is seen as the solution to the narrowness and overdependence of the economy on a few product lines. This to a large extent will mean a policy of import substitutive industrialization which was seen to be constrained by the size of the market, and the high capital intensity of the manufacturing sector which holds the best prospects for creating greater internal linkages in the market. It was also seen that import substitution in the consumption goods area led to only limited success principally because it entailed a high import content of intermediate goods, coupled with small market size, and the uncompetitive nature of these products in the larger markets which were anyway protected by restrictive trade practices. Notwithstanding these obvious barriers to efficient resource use, there is a fundamental need for generating these modern growth sectors, which in all probability will have to be based first on the country's resource endowment, and the comparative advantage that this endowment creates. It may also be necessary to have them protected by tariffs, subsidies, and other measures. Demas (1965) would also use the non-tradable aspect of some activities such as the construction sector as a major source for internal propulsion, since it decreases the import content of domestic consumption. Secondly, given moves to greater autonomy of the monetary institutions, this expenditure in the construction sector can be met by an increase in the money supply with slight depressants aimed at controlling inflationary tendencies.

The above measures will still ultimately be more successful in the large UDC as opposed to the small UDC, which must, as it seems, engage in an industrialization process that is geared to capture the economies of scale which can only be achieved if exports are undertaken. However, there are some critical relationships which must be attained before this export-oriented industrialization process leads to development. The relationship of wages to productivity becomes of crucial importance, and may be one of the major determinants in the success or failure of the programme (Demas, 1965).

In developed industrial countries, an increase in money wages will either cause an increase in aggregate demand, output, and employment without inflation and balance of payments problems if there is a situation of excess capacity, or it will cause inflation, and balance of payments problems if the economy is fully employed, with the effect on output and employment being largely a function of market structure and tax policies. Increasing money wages in a large underdeveloped economy will lead to inflation and balance of payments problems like the case of the near-full employment developed economy, because of the inelasticity of supply that is by definition a characteristic of an underdeveloped country. Secondly, these wage increases may be signal for the rationalization of production by introducing labour-saving devices, thus exacerbating the employment problem, coupled with the fact that it mitigates against capital accumulation, since a larger part of it will be spent on consumption goods with a high import content. As long as the real income increase that this higher money wage facilitates is utilized for import substitution instead of on imports, then the deleterious effects on output and employment will be minimized.

In the case of the small underdeveloped economy whose export sector is dominant, increasing wages in the modern sector will have little or no influence on the level of domestic prices since the price of the dominant export product is determined externally. The narrowness of the production base combined with an increasing real income, and an open economy will result in a larger part of the wage increase being transferred abroad on imports, hence doing little for relieving the unemployment and output problems. Once again, import substitutive industrialization is warranted but this is immediately constrained by size. The only way out of these encumberances would seem to be the development of the modern sectors with an export orientation, coupled with attempts at increasing market size by setting up trading blocks, or regional integration efforts. This latter view has been the central theme of Demas' argument and it is being vigorously pursued in the Caribbean with the establishment of a Caribbean Economic Community which Demas formerly led and of which Guyana is an active participant. Internally, as suggested by Seers (1964), attempts should be made at restricting wage rates to a level below that of the growth of exports, restricting profits in production for the home market, increasing tax rates on companies producing for export, and lowering the share of imports in domestic production. However, as Demas stressed, any policy of wage restraint can only be defended on the grounds that any such saving will be "invested productively within the national economy."

CHAPTER THREE

THE MINING INDUSTRY, EXCLUSIVE OF BAUXITE

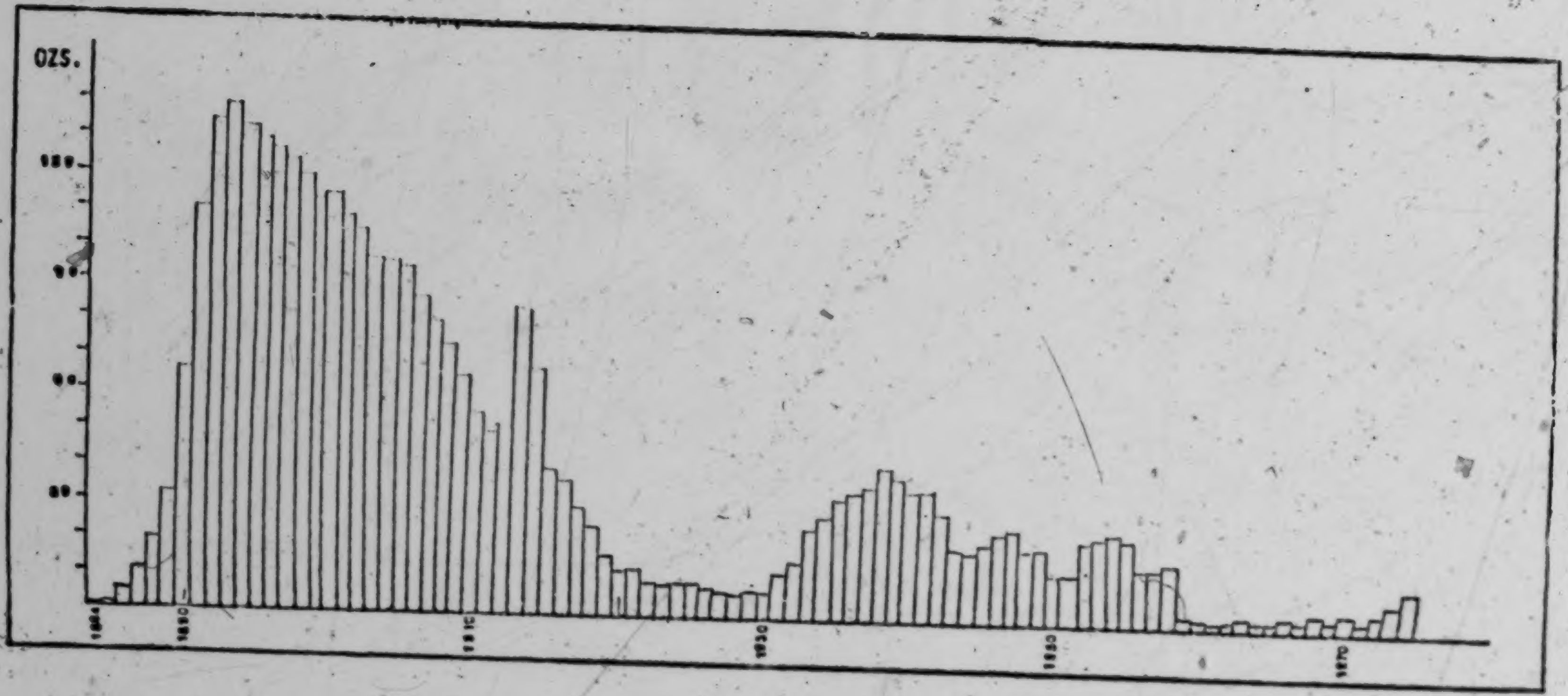
The mining industry, exclusive of bauxite, is dominated by gold, diamond and quarry products, which are all won by relatively small-scale mining operations. Their contributions to the GDP were seen to be minimal in the proceeding section, but this does not detract from their historical and contemporary significance to a Guyana which is attempting to shift its focus of economic activity to the hinterland where these products are located. These small enterprises collectively provide employment for a maximum of 3,000 persons, and though their contribution to GNP is small, they have been a significant source of the import substitution ethic which is so desirable in any economy. They have been a source of capital generation, employment, forward linkages and spillover effects, while helping to conserve on scarce foreign exchange.

THE GOLD AND DIAMOND INDUSTRY

The production of gold in Guyana has had a very volatile history from its earliest recorded beginnings in the 1880's to the present. As depicted in Fig. 3, the overall trend has been towards a general decline in production levels from the 138,528 ozs. of 1893, with minor periods of recovery in 1938, 1954, and 1975. It is certainly significant that the periods of recovery were a direct response to higher gold prices, which arrested the declining production levels attributable to rising costs. Apart from the long periods

FIGURE 3

Gold Production (1884-1975)



Source: Guyana Mines Department

of fixity of gold prices in times of rising cost, the decline in gold production in Guyana is also reflective of the exhaustion of the richer, more accessible deposits.

The smallness of the gold industry is indicated in Table 15 by the fact that in the best of times between 1955 and 1975, gold contributed less than 0.5% to GDP, and less than 1% of export earnings, while its contribution to government revenues via royalty, licences, etc., was negligible. Nevertheless, it does form the backbone of a thriving jewellery industry in which high levels of craftsmanship have been developed. As demonstrated in Table 15, a significant porportion of the domestic production is utilized internally.

Of the six mining districts listed in Table 16, the Mazaruni is currently the most important in Guyana's gold output. The history of gold in Guyana is replete with periodic shifts in importance of specific regions as discoveries are made and publicized. This has resulted in numerous trails, old workings and abandoned, dilapidated shacks littering the forested hinterland. In many areas, these are the only signs of human occupancy, which was controlled by these depleting resources.

METHOD OF PRODUCTION

Up to 1954, when data collection based on method of production was discontinued, alluvial washing accounted for over 84% of the gold produced in Guyana. Dredging, which started about the turn of the 1900's was the next most important method, and it has grown steadily to become the most

Table 15

Gold Production, Export and Royalty

GOLD				
Production			Export	ROYALTY G$
Year	000 ozs	G$000	G$000	
1955	23.8	1406.0	825.5	11,383
1956	15.8	957.0	396.8	7,908
1957	16.5	991.0	498.7	8,240
1958	17.5	1047.0	644.5	8,750
1959	3.4	188.0	39.4	1,724
1960	2.4	132.5	---	1,206
1961	1.7	75.0	0.4	844
1962	1.9	115.0	1.3	954
1963	2.8	199.0	32.2	1,426
1964	2.1	149.2	---	1,058
1965	2.0	142.1	---	1,049
1966	3.0	213.1	---	1,524
1967	2.4	170.5	18.6	1,289
1968	4.0	284.2	---	2,044
1969	2.1	210.0	---	1,052
1970	4.4	572.0	---	2,229
1971	1.4	222.6	---	708
1972	4.0	634.7	---	2,014
1973	7.6	1206.0	298.6	3,776
1974	12.2	3255.0	1791.4	6,120
1975	18.0	5471.0	3539.4	9,127.12

Source: Various files, Government of Guyana Mines Department

Table 16

Gold Production By District (ozs)

Year	Berbice	Potaro	Mazaruni	Cuyuni	N.W.D.	Rupununi	TOTAL
1955	---	21 729	844	130	960	15	23 766
1956	---	14 055	602	190	907	33	15 815
1957	---	11 056	197	3 982	1 205	24	16 491
1958	---	13 818	88	2 297	1 240	29	17 500
1959	---	1 397	124	1 056	1 255	86	3 447
1960	---	314	155	566	1 199	50	2 364
1961	---	291	208	323	828	26	1 702
1962	---	121	346	485	929	3	1 903
1963	---	503	1 104	741	470	4	2 848
1964	---	230	619	267	948	26	2 111
1965	---	330	466	331	769	154	2 077
1966	---	454	270	597	1 278	17	3 045
1967	---	217	347	469	1 326	3	2 379
1968	---	157	3 192	293	388	31	4 088
1969	---	83	1 252	315	397	40	2 102
1970	---	238	2 816	1 257	68	33	4 433
1971	---	219	534	534	95	67	1 407
1972	---	1 366	1 838	586	126	80	4 027
1973	9	1 866	4 490	895	158	105	7 551
1974	---	2 996	7 225	1 764	134	87	12 240

Source: Various files, Government of Guyana Mines Division.

important method in the 1970's. The majority of the gold currently produced is essentially a by-product of diamond mining, and is being undertaken primarily in areas that were once diamond bearing, but no longer profitable on this commodity alone. Appendix (3) shows that up to 1954, dredging accounted for 10% of gold produced, while 4% and 1% were attributed to quartz mining and hydraulicking respectively.

The alluvial operations which can still be seen throughout Guyana's gold fields, are primarily undertaken by numerous artisans better known as "porknockers" in Guyana. They typically use one of five methods to mine the gold; the most important being the "Tom and Chest", which is essentially a long-tom sluice with longitudinal riffles, a screen and a container. The other four methods are variants of the Tom and Chest and these are:

(i) Warrior - containing perpendicular checks and especially good for work on sand.

(ii) Scrambler - basically a Warrior with crosschecks, but made of a local wood, the Baramali skin.

(iii) Bragatash - a ground sluice with wooden checks at an acute angle to the ground.

(iv) Ground Sluice - like a Bragatash, but with vertical wooden checks.

Typically, these alluvial operations require high grade deposits, because the recovery efficiency of these methods is less than 40%, and there is a limit to the amount of throughput which a 2, 3 or 4-man operation can muster. They are characteristically adapted to mining relatively coarse grains of gold, and are notoriously incapable of handling the finer grained, often-times platy gold that is so common in Guyana goldfields. The net result is that these alluvial operations, which to all intents are artisanal in nature, are characterized by high grading. Bucket-line dredging has been able to offset the small throughput of the other methods, but it involves larger capital resources, which are not available to the average miner, coupled with the fact that larger mineralized areas will be required to amortise these expenditures.

Hydraulicking was introduced in Guyana at the turn of the century, and it has only been used for short periods. Typically, it works relatively well for the more proximal, eluvial deposits which are generally of much larger dimensions than the pocket-like alluvial ones. Since larger volumes of waste must be extracted, this requires a degree of mechanization (pumps, monitor, etc.), that cannot be afforded by the traditional porknocker. The government's recent acquisition of equipment for hydraulicking experiments may result in this method being used more extensively, hence increasing the opportunity for tapping the large, low-grade eluvial sources.

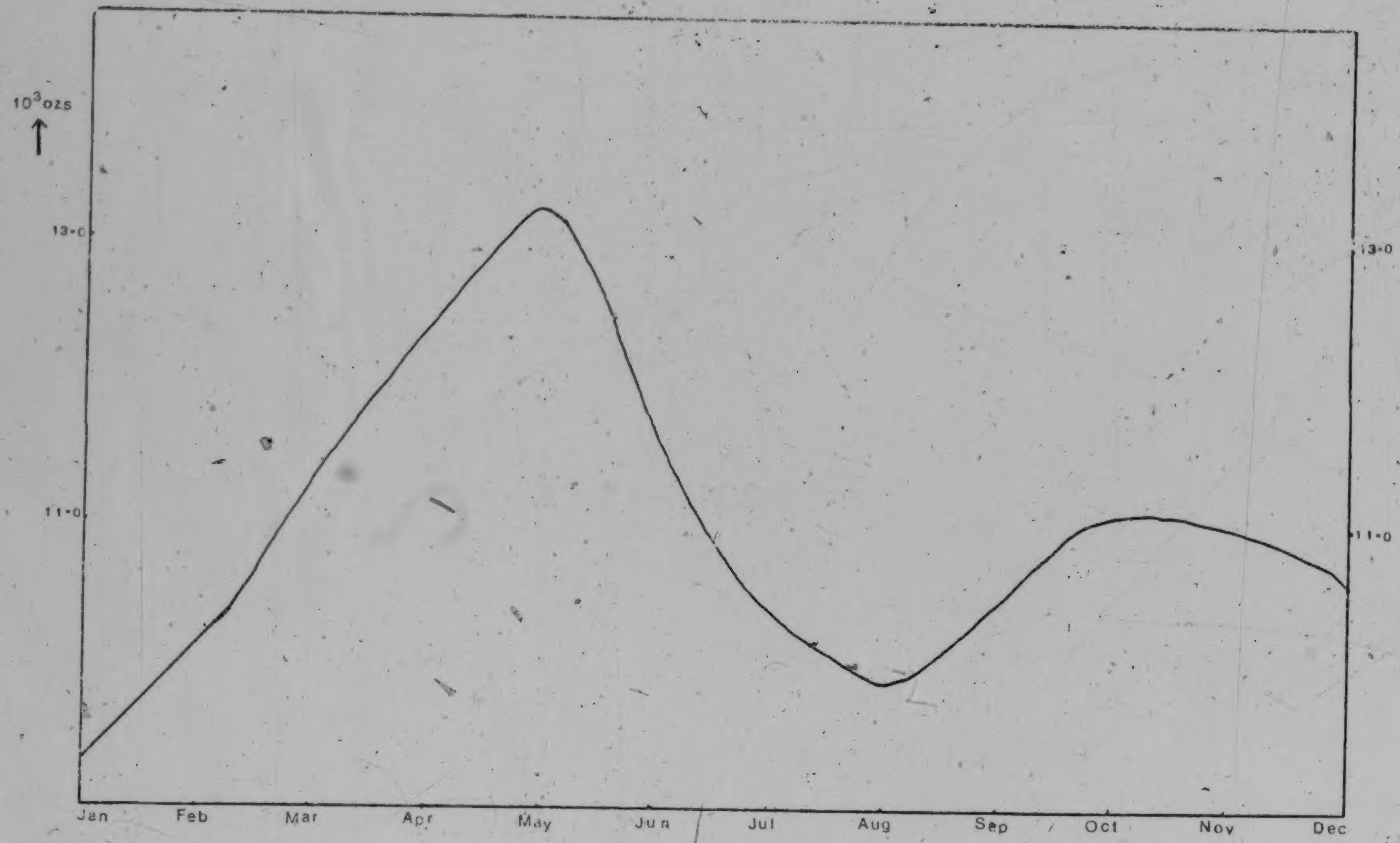
Quartz milling, as can be seen in Appendix (3), has been attempted on a large scale at least twice in Guyana. In this method, the auriferous quartz lode is mined, crushed, and the gold is separated. This is normally a complex operation requiring some degree of mechanical sophistication, hence it is costly. However, the local porknocker has been able to high-grade rich quartz veins by means of a "dinkie", which is essentially a crude stamp mill using the basic principles of levers and mechanical advantage. Lode mining on a scale that can significantly affect gold output is absent in Guyana, and it could be an important area for government attention as will be developed in Chapter 7.

In Chapter 2, it was stated that seasonal variations were a significant determinant of agricultural output, as well as the periods of geologic investigation. Appendix 4 and the visually fitted curve in Figure (4) demonstrates that gold production from 1955 to 1975 describes a monthly pattern that parallels quite closely the seasonal variations in Guyana. The wet seasons are characterized by a drop in gold production, and future attempts by government at sponsoring gold production should actively consider methods that can counter the depressing influence of the rainy season. This will certainly help in stabilizing, to some degree, incomes, revenue and output in the industry, as has been accomplished in the alluvial operations of Sierra Leone (U.N. 1972).

An attempt was made by the author in the summer of 1976 to determine the cost and income structure of the gold industry as it was then constituted. To this end, the questionnaire in Appendix (5) was designed and interviews were conducted. Since a disproportionately larger proportion

FIGURE 4

Gold production by month (1955 - 1974)



of the gold produced in Guyana was by dredging operations in the Mazaruni River, twenty-six of the operators, especially from the then opened part of the Indian Reservation were interviewed.

The results are summarized in Tables 17a and 17b, and they generally confirm the widely held view that this section of the Mazaruni River is well endowed with gold resources at the prices indicated. It does reveal also that over short distances, the amount of recovered gold varied significantly. The high income stream was based on the returns of three operators over a one-month period, while the medium return is the average of the 26 operators canvassed, and it was computed on the assumption that on average, one pennyweight of gold is recovered for each of sixty cubic yards processed by a six-inch dredge driven by a 70 h.p. motor in each day. The low return represented the operator's estimate of the minimum amount of gold which would induce him to remain in a specific location.

An interesting feature of the operations is the fact that variable costs (in this case taken to be essentially composed of fuel and food) is 93% of the per diem cost of the operation. Fuel alone accounts for 67% of working costs and its shortage is one of the most severe bottlenecks in the operation. It is not uncommon for an operation to be shut down for weeks, simply because fuel cannot be brought in sufficient amounts by the Government-operated Guyana Airways Corporation. When this fact is taken into account, the annual income of the miners in no way reflects the large

Table 17(a)

Income Pattern for Dredging Operations

Guyana Dollars

High

Gold Recovery = 6.84 ozs /day
Value at G$300/oz = $2052 /day
Less Cost = $ 310 /day[1]
Net Income = $1742 /day
Sponsors Share (55%) = $ 958 /day
6 Workers' Share (45%) = $ 783 /day
Avg. Worker Share = $ 130 /day

Medium

Gold Recovery = 3 ozs. /day
Value at G$300/oz = $ 900 /day
Less Cost = $ 310 /day
Net Income = $ 590 /day
Sponsor's Share (55%) = $ 324.50 /day
6 Workers' Share (45%) = $ 265.50 /day
Avg. Worker Share = $ 44.25 /day

Low

Gold Recovery = 1.52 ozs /day
Value at G$300/oz = $ 450 /day
Less Cost = $ 310 /day
Net Income = $ 140 /day
Sponsor's Share (55%) = $ 77 /day
6 Workers' Share (45%) = $ 63 /day
Avg. Worker Share = $ 10.50 /day

[1] See table 17b for composition.

9

Table 17(b)

Cost Pattern for Dredging Operations

Guyana Dollars

Total cost for 6" Dredge 70 HP Motor = $30,000
Assume 5 yr. straight line depreciation

	Fixed Cost (260 days)	=	$ 6,000 /year
	Fixed Cost	=	23 /day
*1	Fuel Cost	=	209 /day
2	Food Cost	=	78 /day
	Total Cost	=	$ 310 /day

*1 A 6" Dredge driven by a 70 HP Motor uses up about 39 gals. of fuel per day.

Cost for 45 gals. fuel (1 drum) is $240.70 of which transport cost by Guyana Airways Corporation is $138.00 (i.e. 58% of the fuel cost).

2 For team of 6 persons.

magnitudes that the daily figures would imply. When fuel must be obtained by other private sources, it can cost up to G $300 per drum of 45 gallons instead of the customary $240., when the government facility is used. Victuals in these interior locations are particularly expensive, reflecting, of course, the great transport costs involved.

The survey revealed that 96% of the operators maintained coastal homes, and they typically have been in the activity in excess of eight years, though in a discontinous manner. Typically, a team of six makes up a dredging crew, composed of two divers, diver-foreman, one cook and one mechanic, with each being a partner in the operation, sharing the net revenues of the operation in a predetermined manner. Forty percent of the operations were sponsored by an inactive promoter (backer), who typically claims 40% to 60% of the net revenues as his share. It was noted that 55% was a common figure, and the wealthiest of the group of sponsors opted for the higher 60% share, while the financially smaller sponsors opted for 45 to 55%. Typically, when the operation was self-financed, the worker-boss opts for a smaller share - invariably 45%. Assuming a 55% share for the source of the capital, then the remaining 45% is split amongst the rest of the team with each diver obtaining 10%, the cook 5%, the mechanic 5%, and the diver-foreman 15%. Notable, was the virtual absence of the banks, financial intermediaries, and government as sources of finance. Also of interest is the fact that on average, over a 10-year interval, most operators thought their annual income was less than G $3000. Though one can expect a certain measure of understatement of income, the G $3000 - G $5000 range seems reflective of average annual incomes, which in some cases have to be supplemented by other sources of income, particularly farming on a small scale. The young men on the dredging operations usually join the ranks of the unemployed when they return to the coast.

While the river-dredging operations have been able to attract young men, particularly as divers, the alluvial, land operations are replete with an aging group of "pork-nockers". At Kamarang, an embittered and hostile group of about thirty alluvial miners, who had not worked for about two months, told many stories of their plight, while blaming government to a large extent for the high food prices, the shortages, the non-availability of transport, etc. All of these men, in the true mould of the prospector, were all certain that their silver lining rested with that next trip unto their claims. However, an analysis of the returns given by twelve of them who found it possible to work proved that a meager existence is the norm for these small miners.

On average, the small miner recovers approximately one ounce of gold per week. At G $300 per ounce, he then earns a gross income of G $300. His net income is approximately $158 per week, since he incurs average costs of about $142 per week, composed as follows:

Picks, shovels, a small pump, etc.	$2000.
∴ giving Per week cost for 5 yrs at	$ 9.

Per week cost for food	=	$80.
Per week cost for fuel	=	$53.
Total Cost Per Week	=	$142.

It should be noted that a five-year depreciation for his capital outlay is relatively long, as it is not unusual for him to take a break before this period, hence his potential backers would insist on higher rates of recovery. Secondly, his food and fuel are invariably supplied by the local merchant who contracts to buy a portion, if not all, of the gold at prices well below the going rate elsewhere, hence his net return is extremely small. It shouuld also be borne in mind that the net income of $158. has to be shared between two partners, if not more.

The distribution of claims presented in Table 18 reveals an overwhelming concentration of claims for the mining of precious stones. However, as can be seen from the comparitive data for 1965, 1970, and 1975, the absolute number of claims for the mining of precious stones has decreased by about 50% from 1965 to 1970. This trend is found in the majority of categories of claim holders with different numbers of claims. The smallness of the operations is indicated by the fact that 97%, 88%, 87% and 100% of the claim holders for "Precious Stones", "River Location", "Gold", and "Gold and Precious Stones" respectively, have less than 10 claims. However, in 1970 and 1975, the holders of more than 10 claims accounted for 48% and 33% respectively of the total gold produced in

Table 18

Distribution of Claims for 1965

Types of Claims	Number of Claims																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	47	52
Precious Stones (PS)	416	171	58	30	19	7	7	6	10	2	4	5	2	3	0	4	1	1	0	2	0	2	0	0	0	1	0	0	0	0	0	1	0
River Location (RL)	32	16	13	9	4	6	3	6	1	3	3	1	0	1	2	0	1	0	0	2	0	1	0	0	0	1	0	0	0	0	0	0	1
Gold (G)	40	25	9	4	1	4	1	0	0	0	0	2	3	1	0	1	0	1	0		0		0	0		0	0	0	0	0	0	0	0
Gold & Precious Stones	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0
Merunite (M)	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	1	0	0	0	0	0	0	0

Types of Claims	Number of Claims for 1970																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	28	29	30	32	36	50	51	93
Precious Stones (PS)	324	144	57	34	14	13	3	11	4	3	1	4	5	2	0	1	1	0	1	1	0	1	0	0	0	1	1	0	1	0	1
River Location (RL)	27	15	9	9	9	6	1	4	1	1	2	1	1	1	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0
Gold (G)	35	25	8	4	0	3	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Gold & Precious Stones	27	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Merunite (M)	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Types of Claims	Number of Claims for 1975																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	28	31	32	35	37	39	50
Precious Stones (PS)	208	94	46	35	11	6	11	2	2	6	4	1	2	1	2	3	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
River Location (RL)	27	28	17	10	12	3	4	2	3	3	2	4	3	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1
Gold (G)	53	27	16	9	3	4	0	2	0	1	0	5	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	1	0	0
Gold & Precious Stones	20	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Size of River Location is 1 mile; Size of other claims is 1500 feet by 800 feet.

Source: See Appendix 6 .

Guyana. The reworking of formerly diamondiferous areas for gold is reflected in the absolute, though modest, increase of the number of claims taken for "Gold", "Gold and Precious Stones", and "River Location". Similarly, the larger interest displayed in 1975 for "River Location" claims, reflect the increasing use of the dredge in Amerindian Reserve areas formerly closed to mining activity. Appendix (6) further demonstrates the point that from 1965 to 1975, the Mazaruni mining district was the principal area of interest for gold and diamond seekers.

Diamond production as seen in Table 19, contributed one-tenth of a percent to GDP and less than two-tenths of a percent to total export earnings in 1975. The absolute level of output has varied through the years, but displays an overwhelming contribution by the Mazaruni districts throughout the 1955 - 75 period as displayed in Table 20. About 60% of the diamonds produced in Guyana are of gem quality, while the remaining 40% finds application in industrial uses. It is also evident from Table 19 that a limited amount of the domestic production is used at home, as most of the diamonds are exported.

Most of the diamonds are mined by means of a sluice-like arrangement known locally as a "Tom and Baby". The sluice contains longitudinal riffles like the "Tom and Chest" used in gold mining, and is equipped with a screen and container for the finer gravel/sand. This finer material is then passed through a series of sieves by a process of agitation called "jigging", and the diamonds

Table 19

Diamond Production, Export and Royalty

DIAMOND				
	Production		Export	
Year	English 000 Carat	G$000	G$000	ROYALTY G$
1955	42.4	1764	1345.6	21,200
1956	29.0	1253	1333.6	14,500
1957	28.3	1308	1361.7	14,150
1958	32.2	1361	1384.0	16,100
1959	60.7	3012	3026.8	
1960	98.3	5043	4733.7	49,720
1961	109.7	5627	5134.2	54,937
1962	97.4	4013	3706.4	48,776
1963	97.2	3941	3531.8	48,619
1964	107.0	3843	4773.4	53,542
1965	110.0	5355	5577.8	55,039
1966	90.6	4927	598.0	90,600
1967	97.4	5392	6142.5	97,400
1968	66.3	6330	4750.8	66,300
1969	49.3	4140	3798.0	50,225
1970	61.1	3876	3232.5	59,549
1971	47.2	2974	2474.0	46,703
1972	48.7	2059	1828.6	48,700
1973	52.5	2982	3022.9	52,500
1974	29.2	1812	1798.2	29,200
1975	20.2	1254	1226.6	20,200

Source: Various files, Government of Guyana Mines Department

Table 20

Diamond Production by Districts

Year	Berbice 00 carats	Potaro 00 carats	Mazaruni 00 carats	Cuyuni 00 carats	N.W.D. 00 carats	Rupununi 00 carats	TOTAL 00 carats
1955	---	39.1	197.3	42.5	---	42.6	42.4
1956	0.2	38.0	166.9	29.3	---	56.0	29.0
1957	---	50.4	156.5	19.2	---	56.7	28.3
1958	---	56.7	170.7	42.8	---	52.0	32.2
1959	0.1	30.0	455.4	80.3	0.3	40.9	60.7
1960	---	30.7	793.8	13.6	0.1	23.2	98.3
1961	0.1	90.0	670.9	318.0	---	16.2	109.7
1962	0.2	181.5	706.4	71.2	0.2	14.7	97.4
1963	---	153.7	757.0	56.5	---	3.7	97.3
1964	0.8	276.1	733.0	52.3	---	7.5	107.0
1965	3.8	161.4	783.2	105.3	---	45.2	110.0
1966	14.1	101.1	642.0	86.5	---	61.8	90.6
1967	4.5	111.6	740.0	59.0	---	58.3	97.4
1968	---	116.5	436.0	48.7	---	62.0	66.3
1969	---	99.2	310.3	35.0	---	48.1	49.3
1970	0.8	190.4	278.2	113.2	0.3	27.9	61.1
1971	0.1	72.3	293.3	90.9	---	22.5	47.9
1972	1.7	53.3	256.6	144.5	---	30.6	48.7
1973	3.0	126.5	227.2	118.5	---	50.0	52.5
1974	1.3	89.7	107.8	45.8	---	47.4	29.2
1975	---	68.6	750.0	27.0	---	31.5	20.2

Source: Various files, Government of Guyana Mines Department.

recovered.

It is extremely difficult to assess the level of employment in the gold and diamond industry, as no records are kept for this purpose, either at a central government level or at a district level. Understandably, these records would have to be updated quite regularly, as the very mobile prospector/miner moves to the next "shout". Nonetheless, it must be recognized that planning for the mineral industry as will be discussed in the next section, must take cognizance of the number of people who would be affected. It was decided that a proxy had to be used to estimate the level of employment. Recourse was taken to the revenue files of the Mines Department, especially those relating to licensing. It was then a simple matter of dividing the revenue for each category by the unit cost of that category to determine the quantities involved. Of the four categories listed in Table 21, categories 1 and 4 i.e. the number of prospecting licences and mining privileges would best give that estimate. As explained in the footnote of that table, some double counting is inevitable as holders of prospectors licences may also be assigned mining privileges for another person's claims. However, there are also workers who possess neither prospecting licences, nor have a mining privilege. Categories 2 and 3 dealing with the actual claims are unacceptable, as we saw in Table 19 that one person can hold more than one claim, while not working any of them. The computations show that the unorganized gold and diamond industry is a potential source of employment for about

Table 21

EMPLOYMENT IN GOLD AND DIAMOND INDUSTRY[1]

Proxy Category	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Licences Prospecting	1127	801	1110	1084	1020	717	620	673	675	740
Licences Claims (Gold)	358	399	292	290	372	321	245	426	408	500
Claims Precious Stones.	996	896	1085	1221	1152	869	802	324	781	900
Mining Privilege	3984	2620	3800	2972	2488	1292	1812	1448	1796	2000
Registration Mining Labour	128	220	--	56	44	60	--	72	--	--
1 + 4 = Employment	5111	3421	4910	4056	3508	2009	2432	2121	2471	2740

Sources: Various files in Mines Department (Government of Guyana).

[1] Computation based on revenue collected for the categories listed above. Categories 1 and 4 should represent the maximum number of persons directly involved with mining of gold and diamond, as all workers must either possess a prospecting licence or a mining privilege to actively work on any mining claim. There is some double counting as some holders of prospecting licences may also hold a mining privilege for specific properties.

3000 persons.

ORGANIZATIONAL STRUCTURE

The organizational structure of the non-bauxite mining industry in Guyana runs the gamut of forms from the individual self-employed artisan to the paid employee. Intermediate between these extremes are joint ventures either at an artisanal or more advanced level, and a system of leasing or tributing. Typically, quarrying, to be described next, employs paid labour, while the gold and diamond operations are represented by an admixture of one-man entities, joint ventures and tributing. Not to be overlooked is the role of some storekeepers who behave as the classical grubstakers by providing rations, etc., to the prospector in return for a major share in the proceeds of his finds.

It is apparent that the above organizational structure is a direct response to the financial needs of the industry which apart from the artisanal forms involve large expenditures of capital in an area of great geologic and financial risks. In the more advanced organizational forms, two principal sources of finance can be identified. One can either sell the prospect to a better financially equipped concern while maintaining an interest via royalty, etc., or one can commit contractually future production as collateral for development funds as practised extensively in Australian and Malaysian mineral development (U.N. 1972). Both features will be analyzed fully in later sections, as they pertain to large scale mineral development.

The preceeding sections on the gold and diamond industry revealed that this sector is pervaded by small-scale operations, which contribute minimally to GDP, income and export earnings, but which possibly have some advantages in terms of skill creation, import substitution, and a number of invisible spillover benefits. Admittedly, if these operations are allowed to flourish, they can aid in the natural resource inventory effort, since more areas will be brought under closer scrutiny. A definite gain in exploration effort at the artisanal level is the fact that it is not constrained by capital, while the scale of their operations permit small tracts to be intensely covered.

The question must be posed whether Guyana is adequately deploying her resources by using the organizational forms listed above. One must immediately take cognizance of the fact that small-scale enterprises as observed in the gold and diamond industry are ridiculously notorious for the phenomenon of high-grading a deposit, hence reducing the average grade of a potentially larger deposit, on which scale economies may permit profitable operations of a long duration. Added to this feature, is the noted poor recovery of the relatively unsophisticated mining methods, hence literally wasting a good deposit. As exemplified at Honey Camp Gold Fields where the government ran the hydraulicking experiments (Loncke, 1975), the small scale miner can tie up potentially larger exercises, if in fact the miners are not disposed to cooperating with the larger concern. One cannot overlook the fact that no social security is extended to this sector of the labour force, while there is little incentive for permanence in their operations (in terms of family settlements) since social services are negligible in these areas. The seasonal nature of production was alluded to in a previous section, and it obviously creates instability in income, while the great cover which exists in the Guyanese rain forest, certainly mitigates against small scale mining.

In the specific case of Guyana where increased revenues, income, and employment expansion are stated policy objectives, the recommendation of the continuance of the existing system, particularly in the gold and diamond industry, is highly questionable. It is a fact that some deposits by virtue of their nature of occurrence, location and other parameters, are only amenable to small scale mining. Appendix 7 documents the mineral commodities which are so disposed. However, the declining performance of the industry cries out for better organization, greater financial inputs, and the need to capture the economies of scale of larger than currently functional operations.

While tributing is an organizational form which implies that large tracts of land are available to a more financially capable owner of the mineral rights, hence countering the diseconomies caused by fragmentation, the way it functions in Guyana is tantambunt to usury. The laws do not require the private leasor to commit himself to anything more than the proper maintenance of his claim boundaries (Mining Act 1973). When the word gets out that an area is of interest (in part from the work of the Geological Surveys), the financially capable acquire large tracts of land, which either become immobilized or are made available at a price to the lessee who must carry out the exploration function, and still share his proceeds with the leasor. In the context of a socialist Guyana, the practice should be stopped immediately, as non-functional occupation of land should be frowned on. It can be argued as in Chapter 8 that the government should be the sole leasor of land which it administers in trust for its citizenry.

The co-operative form of organization immediately suggests itself in a Guyanese context, if small scale mining is to be undertaken on account of characteristics inherent in the deposits. It has the advantage of greater financial assets, larger number of participants, reduction of individual risks, while having the potential for generating the sense of community which is so necessary for permanent settlements. It has been argued by Barron (1968) that the larger but lower grade eluvial, alluvial and lode deposits are out of reach of our traditional miners because of the larger volumes of material, etc., that must be processed, and that these deposits were the ones from which Guyana's future gold supply will come. The co-operative seems to fit the requirement quite well, and will be very consistent with the co-operative ethic that is a cornerstone of the government's political and economic policy. Valuable co-operative experiences in mining can be derived from the Tipuani gold placer deposits of Bolivia, the mining co-operatives of Mexico, Tanzania and the very successful ones of Morocco which are involved in the production of lead/zinc at Tafilaet, and manganese at Quarzazate (U.N. 1972). The idea of the co-operative also gets rid of the distateful form of tributing as it is practised in Guyana.

The point is reemphasized that the mining industry, as presently constituted, cannot appropriate the economies attendant to large scale production. It can be argued that changing the organizational form, by instituting of co-operatives in which existing miners would be incorporated will in some measure alleviate this problem, while making larger contributions to the local economy. However, this thesis also argues that the quick breakthrough which Guyana needs to put it firmly on the road to real development, will only be achieved by operations whose scale is much larger than currently exist in the non-bauxite sector. The subsequent chapters are geared principally to investigating this alternative.

QUARRY PRODUCTS

In 1976, the effective demand for quarry products was 660,000 tons, and this was expected to be increased to 800,000 tons by 1978. This entire home demand was to be met by domestic production from the existing five quarries and possibly from two more to be developed at Itabu and Port Kaituma. The inability of present supply to meet the current and projected requirements is underlined by the fact that in 1975, which was a good year for quarry output, the existing facilities produced only 302,000 tons of stone products. The composition of this total is as follows:

Government of Guyana	)Teperu	108,791 tons
	)Makouria	55,748 tons
Toolsie Persaud Ltd.	)St. Mary's	90,900 tons
	)Big Hope	14,920 tons
Baracara Quarries Ltd.	)Monkey Jump	32,180 tons
	TOTAL	302,269 tons

The net result of these facts is that stone availability posed a serious constraint to construction activity, and it will continue to do so until supply can be augmented.

A large part of the supply increase was to be achieved by the government quarries for which a target of 350,000 tons was set for 1976. However, a visit by this author to these quarries in July of 1976 proved that the 1975 production levels were not going to be attained, let alone surpassed. This, to a large part, can be attributed to a serious deficiency in management in the government-run quarries. First to be noted was the ever-increasing already high levels of down-time in the Makouria and Teperu quarries which the government operates. At Makouria, the operations were at a standstill for over 68% of the time in 1976 compared to 63% in 1975. At Teperu, the downtime was 59% in 1975 compared to 58% in 1975. These figures contrast markedly with an average of 35% for the privately-run St.

Mary's quarry run by Toolsie Persaud Ltd., and 33% for the Monkey Jump quarry run by Baracara Quarries Ltd. Management at the government quarries argued that Macouria is being phased out, while non-availability of parts was responsible for the bottlenecks in the operation. This explanation is extremely weak when further probing is done as it became immediately clear that management was not even aware of its spare-stock position at anytime. Secondly, the stores management was not programmed to anticipate parts requirements, but apparently worked on the premise that the part should only be bought when the other has fallen into disrepair. A systems analyst, Mr. T. A. Paul, from the Guyana Mining Enterprise Ltd., visited the property in April 1976, and summarizes quite neatly the chaotic situation by observing that "the present organization, and running of the stores cannot adequately support the Maintenance and Power Supply functions of the Organization", and he went on to describe the impossibility of cost accounting measures, because of the poor records that were kept. The quarry manager did not know how much it was costing him to produce a ton of stone, and this author spent many hours trying to decipher from the available records, some estimate of the same.

For 1975, average variable cost per ton was estimated at G $7.14 per ton, but this figure cannot be easily compared with the cost at other quarries because of the different accounting systems. Toolsie Persaud's St. Mary's operation had an average variable cost of $9.56 per ton in

1976 compared to G$6.02 in 1975. The Big Hope Operations incurred average variable costs of G $7.76 in 1974 and $8.84 in 1975. The treatment of head office expenditures and depreciation may represent the areas of principal difference in the accounts of the various organizations, and the impression is gained that if all the expenditures incurred by the government quarry operations are made visible, instead of being hidden in the Ministry of Works umbrella, the true cost per ton of stone would be much higher. Baracara Quarries Ltd. submitted a complete return with variable and fixed costs and their estimate of $22.93 for a ton of stone delivered in Georgetown is apparently in the correct range for stone products. Based on their figures, Baracara Quarries Ltd. obtained a before tax rate of return of 8%. Toolsie Persaud's operation which is more efficient and on a larger scale, gave an average cost per ton of production of $16.71 when a 15% depreciation on capital goods is used, hence their pre tax return would be significantly higher.

It is obvious that the government operations must be streamlined not only in an accounting sense, but also in the technical operations. The paucity of adequate technical skills was only too apparent at Teperu and Makouria, where decisions with respect to drill spacing and explosives, left a lot to be desired. As far as the private companies are concerned, it appeared that transportation was a significant bottleneck, and it is certainly an area worthy of investigation by government if its building requirements are to be met. Support organizations such as the Police who supervise and control blasting operations should be encouraged to act promptly on applications by the industry, instead of delays in excess of six months which one operation experienced on its application for permission to blast six days per week instead of three.

Regulation of the private operations by government leaves a lot to be desired, as it is completely diffuse, with lines of responsibility being unclear. The practice, as of August 1976, was for the Lands Division of the Ministry of Agriculture to bear responsibility for verifying production and royalty figures, while the Mines Department through one of its officers check on production via its control over explosive distribution, along with the Police Department. Within the Lands Division itself, no clear records are kept of the compulsory (by statute) returns which companies should submit with each shipment of stone products. The disorganization becomes even more serious when one considers that royalty is computed on these returns sent to the Lands Department. In Table 22, the magnitude of the problem is presented as it is clearly evident that quite consistently the declared output for royalty purposes is well below actual output some of which the author verified by examining on site production records. The discrepancies become just as obvious when one compares the amount of explosives used and the declared output, as the latter is normally well below the amount expected (i.e. 1 lb. of explosives for approximately three tons of crushed rock. Personal communications from Mr. Forrester).

Table 22

Comparative Figures on Stone Production (tons)

Quarry	1971 Declared for Royalty	1971 Mines Dept. Estimate	1972 Declared for Royalty	1972 Mines Dept. Estimate	1973 Declared for Royalty	1973 Mines Dept. Estimate	1974 Declared for Royalty	1974 Mines Dept. Estimate	1975 Declared for Royalty	1975 Mines Dept. Estimate
St. Mary's	53,633	135,804	43,786	208,515	42,123	101,850	18,387[2]	80,956[1]	48,642	90,900
Baracara (Monkey Jump)	7,600	45,656	4,500	66,362	5,300	60,735	7,120	57,566	4,356[4]	32,186[4]
Big Hope	2,793	12,336	25,558	12,592	10,411[3]	15,241	17,968	18,296	14,920	---
Skull Point	65,847	215,499	11,500	37,980	---	---	---	---	---	---
TOTAL	130,075	410,795	59,786	325,449	57,834	177,826	43,475	156,818	67,926	123,086

[1] Actual plant records observed on site at St. Mary's, indicated that production for 1974 was 103,030 tons while for 1975 it was 90,900 tons.

[2] Voluntary submission by company to me indicated production for 1974 was 48,733 tons.

[3] Voluntary submission by company to me indicated production for 1973 was 16,535 tons.

[4] The declared royalty was calculated from returns sent to the Department of mines, while the figure of 32,186 tons was submitted to me as production for 1975, and their accounts reflect that the corresponding amount of royalty was paid.

Note: Royalty is simply 25¢ per ton of stone produced.

Some basic recommendations present themselves for increased efficiency in regulating quarry operations. In the first place, the Mines Division of the Department of Energy and Natural Resources as it is presently constituted is the logical organ for regulating the industry since the expertise, and facilities are available from a technical standpoint. It would also give the Mines Division complete jurisdiction over all mineral or related resources explored in Guyana. It would further simplify the existing complicated web of responsibility and obligations from a government standpoint as well as the industry. As far as reporting procedures by companies are concerned, it is recommended that the claims from which production originate, along with the date of shipment, the permit number, carrier vessel, and the destination of the shipment must be recorded. Added to these would be the tonnage shipped and the royalty paid. Records must be kept up to date, so that officers can closely monitor the levels of production and revenue, while requirements for submission of data by the company should be rigidly enforced.

If the levels of employment are to be increased from the 1975 level of about 240 persons, and the production levels are to be raised by government operations, it is seriously recommended that the Quarries Division of the Ministry of Works come directly under the supervision of the Department of Mines. The operations need the expertise of competent mining engineers, instead of relegating technical decisions to a manager who was only briefly trained in quarry management. It urgently requires efficiency criteria on which management decisions can be made, hence the need for proper accounting instead of the current listing of costs or shipment as they occur regardless of the nature of the cost item, and regardless of the timing. It is my contention that there is no justifiable rationale for maintaining the current system, as it is too wasteful and often times counter-productive. The availability of quarry resources is adequate (Schielly, 1968), hence the cry is first for immediate reorganization, before the current errors become compounded.

THE GOVERNMENT PRESENCE

Responsibility for mining activities in Guyana is vested in the Ministry of Energy and Natural Resources which is also responsible for forestry and hydropower development. The Geological Surveys and Mines Department through its head, the Commissioner, is directly responsible to the Minister of Energy and Natural Resources via the Permanent Secretary who is the Minister's principal adviser. Invariably, the Permanent Secretary is a career civil servant whose presence in the Ministry which he officially heads, is more reflective of Civil Service's deployment schemes which do not necessarily bear any relationship to the technical expertise requirements of the various departments. A public servant's experience (in terms of years of service), and application to his job are the basic requirements which are necessary for a man to rise to a position in which he must advise about matters which may literally be completely outside his comprehension, hence his competence. In the specific case of the Geological Surveys, this "Peter's Principle" arrangement has led to less than a harmonious relationship, and changes must be made to the existing system.

The Geological Surveys and Mines Department is supervised by the Commissioner and his Deputy, who in turn supervises a Chief Geologist in charge of geological operations, and a Chief Inspector of Mines, in charge of the Mines Division. The geological operations are conducted by eight geologists who together possess an average post-bachelor degree experience of five years. This has resulted from the departure in the post-independence period of the experienced expatriate geologists, whose places were taken by the currently young, inexperienced group of Guyanese who were trained abroad. Fourteen Geologic Assistants support the geologists in planning and implementing field operations, and it was only in 1975 that attempts were initiated to formally train them in geologic methods. With this basic staff, and a host of ancilliary support sections, e.g. chemistry, photography, drafting, etc., the work of the Survey is performed. A similar situation obtains in the Mines Department where three recent mining engineering graduates, now designated Mines Officers, carry out the task of supervision of the few mining operations mentioned in the section above. Their skill as mining engineers is seldom required in their present role.

In Table 23 is presented the capital expenditures

Table 23

Summary of Capital Expenditures for Geological Surveys and Mines[c]

	1976[1]	1975[2]	1974	1973	1972	1971	1970	1969	1968
Purchase of Equipment	10,000	5,000			10,636				
Geological Surveys	1,220,000	1,500,000	533,180	1,522,000	552,966	286,023	568,588	498,052	558,200
Canada/Guyana Geophysical Survey	500,000			19,000	214,950		*		
Assistance to Miners	200,000	300,000	88,071	183,700	43,767		877	17,807	27,666
Houses for Mines Officers	100,000	45,000							
Contribution to the International Bauxite Association	140,000	140,000	45,863						
Public Relations Programme			97,914						
Membership of the Latin American Energy Organization	50,000	50,850							
Misc. Expense - Nationalization of the Bauxite Industry		1,390							
Ground Seismic Takutu Basin	300,000								
Photo Geological Surveys of Southern Guyana						90	10,554	14,484	11,500
Total - Mines and Surveys									
% of Total Ministry (Capital-Develop)	9.17%	8.52%	18.86%	39.09%	67.57%	94.05%	61.36%	12.12%	16.77%
TOTAL MINISTRY	27,480,916	23,969,953	4,056,352	4,412,126	1,216,988	304,214	945,272	4,375,767	3,561,753

[1] Estimate

[2] Revised Estimate

[c] From 1968 to 1970, Geological Surveys was part of Ministry of Agriculture; then from 1970 to 1973, it became part of a new ministry known as Mines and Forest. From 1973 to present, it is part of Energy and Natural Resources.

Source: Government of Guyana Current and Capital Estimates (1976).

for the Geological Surveys and Mines Department for the period 1968 to 1976. It is difficult to assess the percentage share of geological surveys in the expenditure patterns of the Ministry, because in the eight-year period, it changed from the Agriculture Ministry, to Mines and Forests Ministry, then ultimately to the Energy and Natural Resources Ministry. What the figures do show is that it was a relatively insignificant part of the Agricultural Ministry, and the reorganization which came in 1970 was geared to isolating mining development for special treatment. However, by 1973, the incorporation of the Hydropower Division into the enlarged Energy and Natural Resources Ministry, saw the Geological Surveys relegated to a secondary role as far as capital expenditure was concerned. A similar picture is derived when one considers current expenditure patterns, as total Personal Emoluments which is the largest single (90%) item on the Surveys Current Account, only represents 10% of the Ministry's current expenditure estimate for 1976.

Typically, funding for current and capital expenditures come from general revenue of the central government, but on special projects, the majority of the capital expenditures are met by external aid sources. It was seen in Chapter 3 that in 1976, the Guyanese economy experienced a severe contraction in output, balance of payments, and foreign exchange earnings. This resulted in a severe cutback on capital expenditures in most departments, and the geological survey was particularly hard hit. As in 1973 after the oil crisis, machinery, equipment and men lay idle, while morale fell to an all-time low. In this period 1973 to 1976, five geologists resigned. Three of these represented the most experienced and senior officers, who were responsible for programme planning and development.

The lack-lustre performance of the Survey in the post-1966 period is certainly indicated by the fact that from its 1933 origin, the Survey had put out 36 Bulletins, 5 Records, numerous maps and internal reports. From 1966 to 1969, two more Records and a Bulletin, primarily of work initiated prior to 1966 were completed, along with some consultants reports. From 1970 to the present, similar accomplishments cannot be stated, as only a series of internal reports have been produced. Valiant attempts by the present officers to counter the demoralizing state of affairs have been frustrated as each plan remains on the drawing board, because of lack of funds, and the obvious relegation to lower priority of geologic-related activity by the government.

Prior to 1962, the Geological Surveys was primarily engaged in reconaissance mapping of the country, and this culminated in the first provisional Geologic Map in that year. Subsequent years were to see the entire emphasis of the department shift to exploration and prospection activity. The real success of these attempts will be investigated in Chapter 7 on the likely prospects. However, the question of the suitability of the present organization to carry out the exploration effort must be investigated.

The present Commissioner of Geological Surveys and Mines is a trained mining engineer, with relatively little experience in geologic exploration. His Deputy is a trained Geochemist, who devotes more than 60% of his time to administrative matters, with the remaining time spent diffusely on all related aspects of geology. The Chief Geologist is the only Economic Geologist on the staff, and he only completed his training in 1975. The geophysicist obtained his masters degree in 1976, and has seen limited work because of the cutbacks. The present acting mineralologist/petrologist is not trained for that discipline, while the experience of the rest of the staff has been commented on before. When one considers the Canadian experience where an experienced professional crew of five takes on average 400 seasons in the field to discover a mine (Krüger 1969), the odds with such inexperience, and general exploration difficulty caused by a thick tropical soil profile, are indeed monumental.

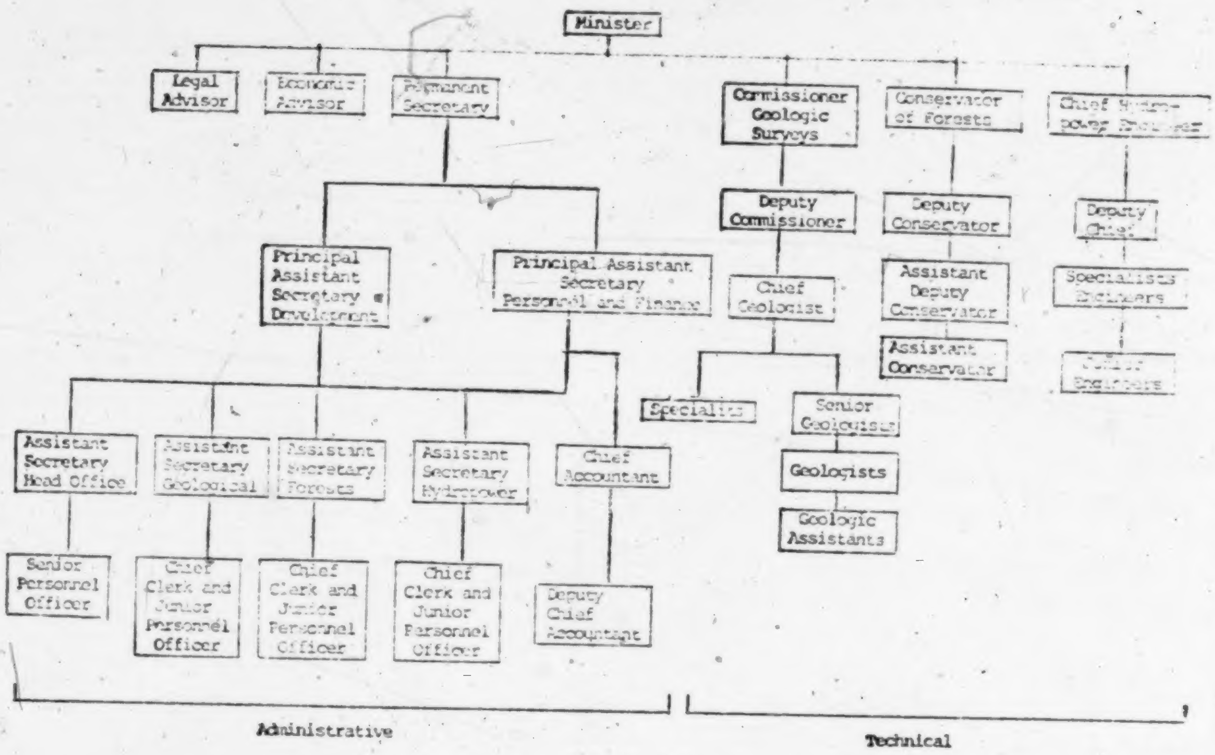
The next question to be answered concerns the adequacy of the existing administrative structure. It has already been intimated that in the upper levels of the structure, a noticeable area of tension has developed. It is my contention that the Commissioner should report directly to the Minister, instead of via an administrative head -- the Permanent Secretary, who in recent years has assumed too great a role in the day-to-day operations of the Survey. Existing technical personnel such as the Deputy Commissioner and Chief Geologist should be relieved of the bulk of their current administrative responsibilities, so that they could perform in areas for which they are trained. These administrative duties which include deploying of vehicles, mechanics, carpenters, office staff, etc., should come directly under the purview of the office of an Assistant Secretary assigned principally to the Geologic Department. The day-to-day operations can be run by the Assistant Secretary's Chief Clerk, while matters of policy, interpretation and longer term implementation would be the direct responsibility of the Assistant Secretary.

In 1972, the Prime Minister astutely called for the creation of a Mineral Development Unit, which has never been formed. Currently in the Geological Survey, a committee comprised of the Deputy Commissioner, the Chief Geologist and the Senior Officers decide on projects, and their implementation. It is here suggested that a Mineral Development Unit which is chaired by the Commissioner be created. This unit will be composed of the Commissioner, his Deputy, the Chief Geologist, and the four Senior Geologists, and the Assistant Secretary, who would be charged with all administrative functions. The Commissioner then reports to the Minister, while the Assistant Secretary reports to the Permanent Secretary, via his immediate superior, the Principal Assistant Secretary. An organizational chart is presented as Figure 5, and it is strongly urged that the Assistant Secretaries be located physically in the same building with their respective departments.

It should be immediately obvious from the chart that the Mines Division has been dropped from its

Figure 5

Proposed Administrative Structure for the Upper Hierarchy of the Ministry of Energy and Natural Resources, Emphasizing the Relationship to the Geological Surveys Department


Minister
Legal Advisor
Economic Advisor
Permanent Secretary
Commissioner Geologic Surveys
Conservator of Forests
Chief Hydro-power Engineer
Principal Assistant Secretary Development
Principal Assistant Secretary Personnel and Finance
Deputy Commissioner
Deputy Conservator
Deputy Chief
Chief Geologist
Assistant Deputy Conservator
Specialists Engineers
Assistant Conservator
Engineers
Specialists
Senior Geologists
Geologists
Geologic Assistants
Assistant Secretary Head Office
Assistant Secretary Geological
Assistant Secretary Forests
Assistant Secretary Hydropower
Chief Accountant
Senior Personnel Officer
Chief Clerk and Junior Personnel Officer
Chief Clerk and Junior Personnel Officer
Chief Clerk and Junior Personnel Officer
Deputy Chief Accountant
Administrative
Technical

original position of answerability to the Commissioner of Geology and Mines. It is my contention that the Mines Division with its staff of Mining Engineers should be the nucleus of a parastatal mining enterprise, with its own lines of responsibility, and measures of efficiency. There seems to be absolutely no sense to the existing use of mining engineers as overlookers of royalty collection, claim distribution and dispute settling. Royalty collection should logically be done by the Accounts Branch of the Ministry while the claim distribution and dispute-settling functions can be easily accomplished by the more senior geologic assistants assigned to that responsibility.

It is therefore proposed that the Mines Division could be reconstituted to include the Quarries Division, and to be charged with the responsibility of undertaking any mining activity on which the government may want to embark. Specifically, it can set about the appriasal with an eye to mining either alone or in conjunction with others, some of the small scale projects which will be identified in Chapter 7. This new entity will also be the agency through which the government might want to exercise its option for joint agreements with any expatriate concerns. The significant point, however, is that it is free of the day-to-day administrative machinations of the government bureaucracy, while having to justify its use of funds, and personnel in a business-like fashion. It should be set up as a state corporation under the Guyana Mining Enterprise Ltd. (Guymine) umbrella, and given the freedom to raise and disburse finances in a fashion consistent with Guymine's standards. The head of such an organization will then be given the responsibility of creating the team he requires to perform the job. It should be mentioned that numerous state mining corporations such as Mindeco in Zambia, and Soquem in Quebec exist and lessons can be learned from their experience. In the specific case of Guyana, this enterprise can provide the technical and commercial expertise that the mining cooperatives, discussed in a former section, may need. As a matter of fact, it is strongly suggested that it be a partner in these cooperative endeavours whenever it is economically justifiable to do so.

The experience of state mining corporations as summarized by Laming and Ajokaiye (1975) has been one of greater control of the country's resources according to government's priorities, coupled with the development of a national capability and expertise in the minerals field. They have also acted as instruments of foreign policy with respect to strategic minerals while keeping open mineral activities when social and other policy justified the effort. However, the above authors recognized that their success depended largely on an adequate supply of finances initially in the first four or five years, with some guarantees that they could pursue the most likely projects with little interference. Of equal importance is the necessity for flexibility and a minimum of bureaucratic control.

The Guymine umbrella is suggested because there is a tremendous degree of expertise which already exists in the bauxite industry, which constitutes the main concern of Guymine. Secondly, the question of funding for the corporation must be taken into account. Apart from the existing technical, financial, and accounting apparatus which exists in the bauxite industry, and which will be required by the new enterprise for maximum efficiency, this study took a cursory glance at the financial accounts of the former Guyana Bauxite Company (Guybau) which has since merged with the Berbice Mining Enterprise Ltd. (Bermine) to form Guymine. The intention is to see whether Guymine can be a potential source of funds for the new company in its initial years.

The highlights of Guybau's 1975 accounts run as follows:

	(Guyana dollars)
Sales	$272.86 m
Cost of Sales	$214.49 m
Earnings Before Tax	$ 52.45 m
Net Income After Tax	$ 25.18 m
Dividend to Government	$ 6.65 m
Retained Earnings	$ 18.53 m
Financial Reserves	$ 45.06 m
Capital Employed	$227.59 m
Return on Mean Capital	13.42%
Net Surplus after Tax as a Proportion of Sales	9%

Exploration Budget	$500,000.
Exploration as a Proportion of Net Income After Tax	2%
Exploration as a Proportion of Retained Earnings	2.6%
Exploration as a Proportion of Net Current Assets	0.6%
Ore Reserves	200×10^6 tons
Current Annual Crude Ore Production	4.7×10^6 tons
Reserve/Output Ratio	42.6

Source: Guyana Bauxite Company Ltd. Annual Report and Accounts (1975).

The level of exploration activity as a porportion of retained earnings and income after tax is relatively modest, since conventional practice can see them attain levels of 10% and 8% respectively, depending on the reserves-production relationship, the marketability of the mineral and the tax jurisdictions. Generally, as will be seen in the next chapter, reserves in excess of 20 to 25 years are worth very little in the marketplace given current levels of discounting. Hence, only when reserves are below this limit, and the marketing relations hold good would companies push the exploration level to the higher levels indicated. In the case of Guybau, the low level of exploration is certainly warranted by proven reserves of approximately 43 years life. It, however, raises the possibility for Guybau to increase its exploration budget to finance the new enterprise, which can be viewed as a means of diversification of the company. This is standard mining company practice and should ensure its long term survival, since it would then be able to shift incremental resources into potentially productive lines, as traditional ones deteriorate.

As suggested by Weihrauch (1976), a consultant from the German Democratic Republic, there is finally the need for the Minister to employ an economic advisor who is familiar with the disciplines of Economic Geology, and Resource Economics, so that adequate control can be administered over the operations of the Geologic Survey, and other mineral related activities under his jurisdiction. From the organization chart, it is then evident that the Minister can very easily be fed information from a group of specialists for the advice he may require to control his ministry. It also facilitates some degree of autonomy for the individual divisions to function in their respective specializations. It hopefully provides the mechanism for localized decision making as the Assistant Secretaries are on the spot to service the technical operations. Another significant change in the chart is the role of the Geologic Assistants, who traditionally were extensions of the Administrative section, rather than aides trained as geologic technicians who are so desperately needed for some of the more routine operations in geologic investigation. Secondly, the Assistant Secretary's Office would be responsible for the hiring of all junior and occasional field staff, along with taking a greater responsibility for obtaining supplies and working out with the technical section, the relevant logistics of the operations, so that greater efficiency can be achieved.

The above organizational chart presupposes that the basic functions of the Geologic Survey are:

(i) The provision of advice to government on appropriate mineral policy matters.

(ii) The provision of the requisite maps and geologic aides which are necessary for an understanding of the resource base of the country.

(iii) The provision of the basic prospection needed to interest the general public - internal as well as external - in the likely economic prospects which may be available.

(iv) Acting as a national repository for all information relating to geology and mineral resources, and

(v) Provision of information and advisory services not only to government, but also to the general public and private companies as well.

To carry out these functions, a minimum level of assured finances is required. With the creation of the mining corporation, it is therefore reasoned that the

Geological Survey should only concern itself with the identification of prospects, and their initial delineation preferably by geologic inference, geochemistry, geophysics and to a lesser extent by drilling. Whatever drilling occurs, must be widespaced and aimed at giving preliminary information on size, grade, etc. This is the level of prospection with which it should be involved, while relegating any further work of an exploration (detailed investigation) nature to the mining corporation, where company efficiency criteria will be the basis on which mineral development will occur. According to this scheme, the level of activity within which the Survey should be functional would correspond to Weihrauch's (1976) "Prognostic Resources" - "Identified Reserves" boundary (see Appendix 8), and is certainly not as capital intensive as the other stages.

Basic geologic research is seriously lacking in Guyana and this dissertation urges very strongly that the Geological Survey take the lead in this area. The problems of adequate exploration techniques for the tropical rainforest must be solved. The problems relating to the geochemical systems which operate in areas of alternate dryness and wetness, coupled with the relationship to the biosphere must be understood; and finally, the buried geology of the Precambrian of Guyana must be brought into sharper focus. These are questions with long term significance, and the Geological Survey must start tackling them. Efficiency criteria would then relate to the successful documentation and publishing on these critical multidisciplinary areas. The majority of the projects should therefore reflect this preoccupation.

The emphasis should be on team-work and not on the number of projects undertaken, as the latter concern invariably leads to work of extremely low quality. Team work allows for the proper orientation of the junior geologist in areas with which he is unfamiliar. It is strongly urged that the Mineral Development Committee explain in detail to a gathering of geologists and mining engineers of the Survey, and the other parastatal mining organizations, of their rationale for the projects selected, and the approach which will be taken. This meeting serves the dual function of making the Committee thoroughly responsible for researching the projects while at the same time acting as a source of information for all the geologists and mining engineers in the country. After the field season and preliminary results are in, the Committee would once again sponsor a second meeting for discussion of results, so that all available expertise can be tapped. These two compulsory meetings will significantly augment the geologic acumen of the available personnel in Guyana. Of course, the co-operation of the state corporations would be sought to permit their geologist to participate fully in these deliberations. The retraining function of these seminars should not be underestimated.

One must also not lose sight of the wealth of expertise in the various disciplines at the University of Guyana, and whenever possible, they should be actively invited to participate in these research functions. Secondly, some formal attachment to various universities overseas is an extremely useful mechanism for tapping other expertise and services. The training of Guyanese geologists and mining engineers at the graduate level could be tied into the overall framework of the Geological Surveys, as outstanding research problems could form the bases for thesis projects under the supervision of the host university, at which the student is studying.

THE MINERS ASSISTANCE FUND

The final concern to which this chapter addresses itself is the Miners Assistance Fund which was instituted in 1973 to aid small-scale mining operations, and which was formally ratified in Parliament as Act No. 5 of 1975 - "The Miners Assistance Act 1975". In the Act, a fund to be administered by the Minister through an Advisory Committee was established to subsidize miners in transportation, purchase of equipment, maintenance of a mine, and generally for the defraying of expenses associated with their mining operations. The maximum size of any loan was set at G $5000.

The story of this scheme in the 1973 to 1977 period is presented in Table 24, where it is immediately evident that only 22% of the total value of loans amounting to over G $143,000. was repaid. The 112 beneficiaries received an average of G $1,279. each, and repaid an average G $287. It is also obvious that the number of loans dropped radically from 1973 when 77 were given to none in 1977.

This probably reflects the disenchantment of the

Table 24

Miners Assistance Fund

(Guyana Dollars)

Year	No. of Loans	Total Loans	Average Size of Loan	Repayments
1973	77	$ 86,967.52	$1,129.00	$ 7,390.62
1974	10	3,818.35	381.00	13,481.92
1975	17	29,532.90	1,737.00	2,876.43
1976	8	22,944.50	2,868.00	7,020.50
1977	--	--	--	1,379.50
TOTAL	112	$143,263.27	$1,528.75	$32,148.97

Source: Ministry of Energy and Natural Resources (1978).

Ministry with the programme, and understandably so. Even though the Act provides for adequate security, it is doubtful whether they were actually obtained, and even more doubtful if the government would institute recovery methods.

Though in principle miners-assistance schemes sound good, the experience with funding of this nature has been extremely bad in a number of countries (U.N. 1972). It has been found that to properly supervise the loans would be too costly, while they are discriminatory against those who may not have the lobbying potential to present their cases. It has also been the general experience that the notion of the benevolence of government mitigated against repayment motives.

This has resulted in countries such as Chile, Peru, Southern Rhodesia and Turkey implementing an assistance scheme which is not directly related to funds. For example, the Geological Surveys can undertake to analyze a specific of samples in the course of a year. In Chile, the government has set up custom mills to treat the produce of the small miner, but notably they all shy away from the loan of funds. The idea of free analysis raises the question of sampling methodology, and the opportunity can be seized by the Survey to upgrade the skills of its indigenous prospectors through short formal meetings. In my estimation, the existing scheme should be dropped, and interested applicants directed to the mining corporation for advice, and possible follow-up depending on the corporation's priorities. An interesting feature of the scheme is that even though an elaborate Committee was set-up for handling the loans, "no follow-up information is gathered from loan recipients in respect of the type of minerals recovered or the success of their ventures" (Hall, personal communication).

SUMMARY

In this chapter, an analysis of the non-bauxite mining sector was undertaken. This sector was primarily composed of gold, diamond and quarry products which were seen to be relatively small contributors to national output, income, export earnings and employment.

Financial analyses within the gold and diamond industry reveal an extremely volatile, and on average, low income stream, which was invariably supplemented by other sources of income derived from attachment to other sectors of the economy. The analysis concluded with the finding that the small scale operations as presently constituted could not adequately meet the test of adequate resource use, because of the phenomenon of high-grading added to a near exhausted supply of the accessible deposits. It was suggested that the formation of mining co-operatives could counter the diseconomies of small scale production, while providing some of the dynamic for more stable operations. However, their net impact on the national scene is still considered to be quite small.

An examination of the quarry industry showed that acceptable levels of returns were being achieved. However, current production relations especially in the government-run operations left a lot to be desired. It was suggested that the government-run quarries division come under the purview of the Mines Division, which itself was to be reorganized as a crown corporation. Stricter and more meaningful supervision was urged for the private operations.

The impact of government on this sector was next investigated, and following an analysis of the existing organizational form, some fundamental recommendations were made. The changes emphasized functional responsibility and the need for greater localized decision making. The Minister of Energy and Natural Resources was to be serviced directly by his technical heads of departments and the administrative head. The office of the Assistant Secretary was to be reorganized to permit administrative decision making within the specialist departments, instead of the current practice of using technical experts as administrators who anyway had to refer the administrative problems to Head Office, because of the complex lines of responsibility.

The creation of a Mineral Development Unit was highly recommended, and the orientation of the Geological Surveys to research and long term projects was to be emphasized. The more immediate problem of exploration and actual mining was to be assigned to a crown corporation which will incorporate the existing Mines Division. This corporation should come under the Guymine umbrella, and should be considered as the nucleus for diversification of Guymine into other mineral product lines. It was strongly urged that this corporation provide the expertise in the running of the mining cooperatives with which it will engage in partnership agreements. It was also conceived as the state's participant in any future joint ventures with external capital.

Recognizing that the small-scale mining sector, if properly planned and administered, can only make significant contributions to growth and development in the very long term, the enquiry now focuses on the characteristics of large-scale mining activities, with an eye for isolating those features which hold the best prospects for growth.

CHAPTER FOUR

CHARACTERISTICS OF MINING INDUSTRIES

Some Problems of Definition

An imperative departure point in the economic analysis of the actual or potential contribution of any resource to development, is an understanding of the characteristics of the said resource and the implied interrelations that exist between this resource and those which contribute to its form. Ciriacy-Wantrup (1959) viewed the concept of a resource as a dynamic one which changes with the end-means scheme, i.e. with the planning agent, his objective, the state of technology and the existing social institutions.

With respect to the mode of occurrence, Wantrup defines three kinds of resources, namely: "natural", "cultural" and "human". On the basis of utilization and the time distribution of use rates, these resources may be defined as "exhaustible" or "inexhaustible". Here, the major determinants of resource availability are wants, technology, effects of cumulative use and finally variations in the physical quantity and quality of the resource over time. "Exhaustible" was construed to imply the discontinuance of further utilization in the face of continuing human wants, as costs of production become higher than revenues to continue further use; whilst the corollary was used for the case of inexhaustible resources. It is clear that the time pattern of revenues and costs is the main consideration in this classification, and as there is a whole range of possibilities for the intertemporal distribution of revenues and costs, the distinction between "exhaustible" and "inexhaustible" becomes one of degree.

A better classification of resources, (one that has gained widespread acceptance), is based upon their availability in different time intervals. Resources may either be "stocks" or "flows", with analogous terms being "non-renewable" and "renewable" respectively. A stock or non-renewable resource is one for which the total physical quantity does not increase significantly with time. In contrast, a flow or renewable resource is one for which different units become available for use in different intervals. Implicit in the definition of a stock resource is that present use will diminish future availability, while in the case of a flow resource, present flow does not necessarily diminish future flow, although there are some noted exceptions in the latter, especially where a critical zone is involved. There are two major classes of stock resources dependent upon their future availability when no current use is undertaken. Most mineral resources fall into the first category wherein the resources do not decrease significantly with time if there is no current consumptive use, while oil and a few fugacious resources fall into the category of resources whose future availability is affected even without current consumptive use due to loss by seepage, etc.

While consensus seems to have been achieved with respect to the definition of the above broad categories, the same cannot be said for a definition of mineral resources which would lend itself to rapid, easy and acceptable measurement. A voluminous mass of literature has developed on this subject and apart from the differences of perspective of the various advocates, there seems to be emerging, at least in notional terms, an appreciation for what a mineral resource category is meant to convey. The emerging concept is that mineral resources should be defined with respect to their usefulness as inputs to economic activity, and not with respect to their physical characteristics. As Zimmerman (1951, 1964) observes, "Resources are not; they become.....they are living phenomena, expanding and contracting in response to human effort and behaviour". However, one recognizes that a definition based solely upon the utility of the material in economic activity leaves unanswered a whole spectrum of far more important questions as to the measureability of the resource and the terms of its availability. These particular concerns have engaged the attention of industry practicioners for a long time and have been the subject of intense scrutiny by academics from the time of Leith (1938), through Blondel and Lasky (1956), Lovering (1969), and more recently McKelvy (1972), Zwartendyk (1972), Govett and Govett (1974), Brooks (1975), and Walrond and Morton (1977).

The central points of contention may be summarized as follows:

(i) The need to create a classification that gives a fair reflection of the total available quantum of mineral material which can be converted into useful products.

(ii) The need for further sub-classifications which facilitate discrimination between mineral materials of different volumes, grades, chemical and mineralogical characteristics, modes of occurrence, and locational parameters as they impinge upon their economic recoverability.

(iii) The need for consistency in the use of the terms which purport to describe a given subset, so that the additive requirements needed for determination of availability may be accomplished.

(iv) The need for universality in the classification, so that the resource manager, the national government, and the international organizations may refer to the same yardstick for resource management considerations.

For the purpose of this dissertion, except where explicitly stated, a mineral resource will be defined as:

"the total amount of an element, compound or mineral assemblage - both known and unknown - down to some defined grade which is higher than the crustal abundance of that element" (Govett and Govett 1976). One should mention here that the minimum defined grade of Govett and Govett is similar to the grade associated with the "Energy Barrier" as defined by Walrond and Morton (1977). However, since very little is known of the nature of the energy barrier, one is justified in using the looser definition of an unspecified lower-most grade, whilst remaining cognizant of the fact that a geometric increase in energy is required to convert material of a lower tenor, and that this would require a whole new technological input, rather than incremental changes of technology which were suitable up to that grade. Resources will encompass three categories, namely:

(i) Non-economic resources
(ii) Sub-economic reserves
(iii) Economic reserves

The present author has recently discussed the concept that "a mineral reserve represents a measured quantum of a mineral resource for which the grade is equal to or greater than the minimum grade established by the best available current technology, which promises to yield an opportunity rate of return on investment just greater than the next best alternative use" (Walrond and Morton 1977). Mineral reserves can then be divided into "economic reserves" which can be currently exploited at a profit, and "sub-economic reserves", which cannot currently be exploited at a profit, either because of inadequate tonnage, grade and price, or due to inadequate quantification while taking into account distance from market and the numerous exogenous physical features of terrain and mode of occurrence. The non-economic resource will then be the total resource minus the sub-economic and economic categories. One should mention that supply is drawn from reserves and is subject to the omnibus variables which determine profitability and risk minimization, hence it is the most volatile of those categories mentioned above.

DETERMINANTS OF MINERAL RESOURCE AVAILABILITY

Inherent in our definition of resources is an implicit assumption that mineral resources represent anomalous accumulations, whose physical existence is only ascertained after search or by incidental encounters. The coincidence of anomalous concentrations coupled with large sizes of the concentrations are a basic requisite for the formation of a mineral resource. The probability of occurrence of these two features is extremely low when one considers the distribution of known mineral resources with respect to the available landmass. Apart from the volume and grade, each deposit has a peculiar mode of occurrence, mineralogical and chemical peculiarities, and a host of "eccentricities" which allow it to be characterized as a unique body. Attempts at systematizing the areas of potential occurrence have led to the concept of metallogenic provinces which continues to be the subject of active research in the geological profession and which will be discussed more fully in Chapter 7.

All definitions of mineral resources contain as an essential element, the degree of assurance of availability, which availability is always specific to a given technology. While technology allows the finding of hitherto unknown deposits and augments the recovery of the valuable metals or non-metals from their hosts, it can also affect the demand for the mineral by either fostering more intensive use of the mineral in existing products or by creating new products. Conversely, by provision of substitutes either at the input or output stages, technology can have a deleterious effect on the demand for the mineral.

The copper industry, which is extremely old, has been both benefactor and victim as a result of technological changes which have affected both the demand and supply ends of the equation for this metal. At the turn of the century, breakthroughs in mass concentration techniques facilitated the exploitation of porphyry copper deposits, and with supply increased, it is essentially technological breakthroughs in the electrical, construction, coin and cupro-alloy industries which made the utilization of this supply possible. However, later technological developments, resulted in the highly conductive, lighter-weight metal aluminum making significant encroachments into the traditional copper markets, and copper producers cannot now be unmindful of further aluminum invasion in the future. Similarly, aluminum which is typically very energy intensive has seen a systematic reduction in this energy intensity, thus augmenting its supply prospects from lower grade bauxite sources. It is to be recognized as well that should the prices of aluminum grow prohibitively high, then limitless supplies of it may be made available from sources such as clay, alunite, nepheline and feldspars. The point is therefore made that technological change is one of the important influences which can lead to shifts in the positioning of a particular known reserve as economic, sub-economic or non-economic at a given time.

Capital and entrepreneurship are the necessary cooperant factors to labour in the production of any economic goods whether mineral oriented or other. Traditionally, the level of income of the mineral investigator did not seem to bear any systematic relationship to the ability to find mineral deposits (Wendel 1968). In North America, the small prospector with limited income and capital outlay has been principally responsible for a proportionately larger amount of mineral finds, which are increasingly becoming more difficult as virgin, unexplored areas become more scarce, and more costly indirect methods have to be undertaken. On inclusion of all the facets involved in mineral activity from the exploration to the marketing stages, it is therefore not surprising that only the large conglomerates with their access to capital markets and their reserves of internally generated funds will be able to bridge the "discovery - development barrier" as Wendel (1968) puts it.

In the Canadian experience, Cranston and Martin (1973) reported that exploration expenditures increased five times in the period 1946 - 1971, while Roscoe (1971) using data provided by Derry (1970) concluded that the probability of finding a deposit based on an average exploration cost of (Canadian) $30,000. per try, has been reduced ten times from 1951 to 1969. In the 1970's, Bosson and Varion estimate that each major mine discovery in Canada incurred a cost of approximately (U.S.) $300 million. Comparable figures for Australia and the U.S.A. are (U.S.) $12 million and greater than (U.S.) $30 million respectively. On average, a successful North American exploration programme is thought to involve an annual budget of approximately (U.S.) $3 million for each of about five years.

Given the possibility of a natural concentration of a mineral resource, the appropriate technology, and the required level of venture capital, it would be fair to assume that no development will take place until questions of "the right to use and enjoyment" , "the executive right to manage" and "the power of alienation" of the resource are settled (Thompson 1976). This bundle of rights that confers ownership and control (i.e. property rights) is of the greatest importance in problems of jurisdiction of any resource. Where there is a lack of property rights, responsibility becomes difficult to determine and externalities abound. "As societal organization requires the division of labour and roles to be specific, the bundle of rights which separates any two entities must also make their responsibilities and obligations distinct" (Walrond and Morton 1978). Though definiteness of property rights is not a panacea for efficient use, it certainly is a necessary condition to orderly exploitation.

In most resource industries, and in the mineral industry in particular, property rights have been everything but definite. One can recognize cases of the intertemporal "instability in property rights" where the rights to use and enjoyment are tenuous (Ciriacy-Wantrup 1959). Changing political and social regimes are tremendous generators of instability in property rights, and will consequently affect the terms of availability of the resource. Mineral projects have long maturity periods, and it may be necessary that future exploitation patterns would have to accommodate the every-increasing demands for redistribution of wealth that are sought by the lower income groups. Though this aspect may not be significant at the commencement of the operations, it will pervade the thought of all as the operations mature and profits are realized.

In the literature of project evaluation, great attention has been paid to the situation of an "imbalance of property rights", where externalities typically occur because the economic agent cannot appropriate the benefits external to his activity nor is he held responsible for the external costs he inflicts on society, but rather the agent is principally concerned with his private benefits and costs to the exclusion of the effect of his activity on society. The implications of this for mineral resource availability is that inefficiencies in resource allocation may be involved, as the socially optimal amounts of resource inputs are not utilized in the production process.

Indistinct property rights that ascribe equal responsibilities, rights of use and probably ownership to the entire group of economic agents (i.e. res communis resources) have been well described by Gordon (1954), Scott (1955) and Copes (1972) for the fisheries. The general characteristics of common property resources are inefficiencies in production, coupled with over investment, over exploitation, and the dissipation of any potential surplus or rent. In the mineral industry, this type of common property resource will generally occur in areas of very primitive mineral activity where crown or community tribal lands are open for all to eke out an existence.

In some cases, there are no codified or even traditional property rights except those possessed through capture (res nullius). Of all the states, this is possibly the worst, as individual survival dictates that all of the resources must be captured, before politically determined rights of ownership and use occur. In the case of common property resources, there is usually associated some form of jurisdiction that regulated entry and exploitation, while in the case of these fugitive resources, there is no regulation (Ciriacy-Wantrup 1959). The concomitant over investment, over exploitation, dissipation of surplus, and possible depletion that characterizes the case of the common property resource are more pronounced in this case, and often times, the declaration of such areas as common property is in part a solution. Knight (1975), Green (1977) and Walrond and Morton (1978) discuss the possibilities of manganese nodules falling within this category of resources. Similarly, ground water and migratory oil, in the absence of any unitization agreement can be so classified. The implications of all these states of indefinite property rights on production decisions will be discussed in the next chapter, but it should be pointed out that the major rationale for the phenomenon of "high-grading" by most mineral operators can be found in situations arising from the indefiniteness or instability of assured property rights.

The institutions that exist in a country theoretically reflect the interest and aspirations of its inhabitants and hopefully they provide the instruments for the achievement of those aims. The royalty and tax structure, insofar as they reflect the attitudes of the society to the distribution of the returns to the various factors of production, will significantly affect the product-mix and will dictate by whom economic activity will be undertaken. The maturity of the health and education institutions, degree of unionization, the extent of social welfare systems, etc., will determine the quality and conditions of availability of the labour force, while the banking, and financial institutions will determine the amount and terms of availability of capital. The role of the judiciary and a stable legal system with a reputation for the observance of the tenents of jurisprudence will combine with the above institutions in determining the timing of development of mineral resources.

The actual endowment, the availability of capital and technological know-how, and the state of property rights are the determinents which make the resource physically available. They are to be considered as responses to the original source of availability, which is rooted in the galaxy of influences arising through the evolution of societal tastes and demands for final goods and services. These specific determinants have been isolated here, essentially to bring to the fore some of the main elements that must be reconciled if mining is to play a part in the country's development.

MARKET STRUCTURE

Fundamentals of Market Classification

In the simple case of an homogeneous product, for which the relationship between the various production units is visibly apparent, the market structure is easily determined. However, the mineral industry which is basically 'multi-stage' and 'multi-product' does not lend itself to such ease of categorization as each stage (exploration, development, mining, milling and concentrating, smelting, refining, manufacturing, sales) and each product have unique characteristics which may give rise to structures of their own. Even though it may be difficult to make any a priori generalization about the structure of the industry, it is instructive if an attempt is made to isolate those features which are common to the various stages and products, so that they may be given explicit treatment in the economic calculus. Such an analysis will hopefully set the stage for the rejection or acceptance of some of the commonly held notions about the role of the mineral industry, and the treatment it deserves in policy determination. Mead

(1967) elucidated these types of relationships in the lumber industry which was always considered to be highly competitive because of the numerous economic units at the output end, but which in fact exhibited tremendous degrees of concentration in the primary stages of the production process.

In any product group, such features that contribute to the exclusivity of any of the products will contribute to the manifestation - even if it is only transitory - of monopoly control. The differences in size, quality, technology, property rights, costs and location that were described as the determinants of mineral resource availability, will all in some way confer some degree of exclusivity to the mineral, hence it may be intuitively expected that elements of monopoly control will develop. The search for the relevant market form will be approached by a brief review of the distinctions between the kinds of quasi-monopolistic behaviour and of market structure.

The bases of market classification are the importance of the individual firms in relation to the entire market and the homogeneity of the product. This classification allows the recognition of broad categories of pure competition, pure monopoly, oligopoly and monopolistic competition. The case of pure competition requires firms that are atomistic in relation to their market, an homogeneous product, absence of artificial restraints to level of output and prices, and free mobility of goods and services. Pure monopoly occurs when a single firm has the market for a product, which has no, or any near substitues, all unto itself. Consequently, the industry demand curve is the demand it faces, and the lack of substitutes reflects itself in this curve being relatively inelastic, while the cross elasticity of the monopolist's product in relation to others is zero or very small. Unlike the case of pure competition where the firm had no perceptible influence on demand, price and output, the monopolist can control output and price and even the demand curve itself by different forms of promotion.

In the case of pure competition and pure monopoly, the product is essentially homogeneous. However, certain types of market behaviour are noticed where many sellers are present, but they typically have a differentiated product. Each participant, like the case of pure competition, has no perceptible influence on output, price and demand, but he may be able to affect the demand only slightly for his own differentiated product. The abundance of substitutes (hence high cross elasticities) makes the latter only of negligible significance, while the demand curve is highly elastic, but probably not as high as the infinitely elastic demand curve facing the pure competitor. Actions on his part to affect his price and output will generally not be met by retaliatory measures of other firms as is the classic case in the next form of market structure to be studied.

The oligopolistic industry is characterized by a great degree of interdependence of a small number of firms, whose independent actions with respect to output and price will affect the market shares and prices of the others.

One can distinguish cases of pure oligopoly where the product is homogeneous (e.g. aluminum, steel and cement industries), and cases of differentiated oligopoly where the product is heterogeneous (e.g. different makes of cars, etc). The interdependence of the firms is largely responsible for the indeterminate demand curve that an oligopolist faces. However, with maturity, the firms develop perceptions of their market shares, and the codes of conduct which are required for their mutual existence. These codes of conduct are either developed through some form of collusion, either perfect in the case of centralized, or market-sharing cartels, or imperfect in the case of tacit informal agreements such as price leadership, and areas of influence, or they could be achieved through independent action over time.

The case of perfect collusion can essentially be translated into a monopoly structure, where the individual firms are agreeing to maximize industry profits by equating industry marginal cost with industry marginal revenue. The share of each participant can be highly variable depending on the formula for sharing, whether by the respective firms cost structure, geographic location, overall size or whatever. In the case of imperfect collusion, the mechanism for market stability is invariably that of price leadership (Wilcox 1940): price leadership may be established by the low-cost firm, or by the dominant (largest) firm in the industry. In either case, it is the cost structure of the leading firm that determines the level of prices, hence output that will prevail in the industry.

Independent action by firms in an oligopolistic market may evince retaliatory action on the part of the other firms, thus leading to serious fluctuations in output and prices. If one firm undercuts the prevailing price in order to capture a larger portion of the market, then a price war can develop as the other firms react by cutting their prices to either regain their market share or penalize the firm initiating the cut in price. Mindful of price wars, firms are more inclined to maintain a cluster of prices about the "accepted" norm, and engage in non-price competition such as product differentiation, and advertising. The knowledge that undercutting of price would unleash similar responses by other firms, while price increases may go unrivalled in a mature industry, has led to the phenomenon of the oligopolist's "kinked" demand curve. Essentially, the kink represents the price below which the demand curve facing the firm is relatively inelastic, while above that price, the curve is very elastic. Because of the precipitous change of the marginal revenue at the quantity defined by the price where the kink in the demand curve occurs, different cost structures will not affect the level of output of each firm, once the marginal cost curve intersects the marginal revenue curve in the vertical portion.

Oligopolistic markets will of course degenerate to pure or monopolistically competitive markets if entry is free and easy, especially if supranormal profits exist. Perpetuation of the oligopolistic form hinges on greater collusive actions, and on natural and artificial barriers to entry. The two more important natural barriers are the size of the initial investment, and the size of the market with respect to the optimum scale of plant required. Large capital requirements and small market sizes with respect to optimum plant size are obvious barriers to entry. Artificial barriers can be established by degree of product differentiation and the consumers identification with it, coupled with the intimidatory pricing policies of already established firms. Government patents, licences and regulations with respect to the manner of operation, location and timing of development of some industries may constitute barriers to entry. Finally, and quite importantly in the mining industry is the need to control strategic sources of raw materials.

Observations of Market Patterns

Basically, about 90% of the ore produced in western economies is accounted for by approximately 1250 mines of which 600 are underground - 450 are open pit - and 200 are alluvial - operations. Typically, these operations have annual capacities well in excess of 150,000 tons ore per year (Bosson and Varion 1977). Using Canada as an example, the 1965 figures reveal that there were 3860 mining corporations with total assets of U.S. $9000 million, sales of $3,200 million, and profits of approximately U.S. $650 million. Of this group, 46% of the profits, 44% of the sales, and 36% of the assets were accounted for by 16 (i.e. 4%) of the companies (Bosson et al 1977). Kruger (1969) demonstrated that four companies accounted for nearly 20 to 25% of exploration expenditure in Canada during the 1960's.

Within specific commodity groups, a similar concentration pattern and market structure can be developed and will be illustrated for the copper, nickel, aluminum, and platinum industries, while Table 25 indicates the same picture for a number of mineral products in the United States.

In the case of copper, for which the free-world production in 1975 was 4,654,600 short tons, the United States alone accounted for approximately 28% of this output, while the U.S. and Canada combined to give a North American contribution of 38%. Of this North American output, the first signs of concentration can be gleamed from the fact that six companies, namely Kennecott, Phelps Dodge, Asarco, Canadian Copper Refiners, and International Nickel of Canada possessed approximately 71% of the copper refinery capacity (Metal Statistics 1976). A disproportionately large percentage of the world output of copper is controlled by Kennecott - the largest privately owned Cu company in the world - the five nationalized mines in Chile and Peru, Noranda Mines Ltd., International Nickel Co. of Canada (INCO), Mt. Isa in Australia, and three big groups in Zambia and Zaire. In the United States, out of the 200 producing copper companies, one produces 31%, four produce 79% and nine produce 91% of all the copper mined, while out of nine companies engaged in smelting, one produces 30% and four

Table 25

Index of Concentration in the Mining Industry

		Copper Mining	Copper Smelting	Gold	Iron	Lead Mining	Lead Smelting	Magnesium	Molybdenum	Silver	Tungsten	Zinc Mining	Zinc Smelting	Uranium Mining	Uranium Milling	Coal	Boron	Feldspar	Fluorspar	Gypsum	Phosphate	Potash	Sulphur
Line 1	# of Companies or Mines	200	9	1000	179	500		4	14		690	300		730	20	7900	4		26		24	8	
Line 2	# Producing Line 3	1	1	1	31	7	6	1	1	25	40	7	11		7	70	1	10	3	10	1	4	4
Line 3	% Produced by Line 2	31	30	40	78	65	100	90	73	84	92	64	98		69	78	66	92	64	82	50	50	100
Line 4	# Producing Line 5	4	4	2						1	5	4			3	1		3			1		
Line 5	% Produced by Line 4	70	67	57						15	48	56			47	9		65			20		

Source: Kruger (1976).

produce 87% of the copper smelted (Kruger 1976).

The nickel industry demonstrates concentration even more glaringly than that of copper. In 1975, world smelter production of nickel was 641,000 tons of which North and South America accounted for 33%. Of the total American production, INCO Ltd. and Falconbridge Copper Ltd. accounted for approximately 80%. From a world perspective in 1975, INCO, Falconbridge and Sumitomo Ltd. of Japan have 57% of the estimated annual world smelter capacity. It should be observed that these are minimum figures because they do not take into account subsidiaries of those groups that are not overtly identified as such.

The aluminum industry shows a dominant concentration of world output in a few large North American companies, namely Aluminum Company of America Ltd. (Alcoa), Aluminum Company of Canada Ltd. (Alcan), Reynolds Metals Mines Ltd. and Kaiser Ltd. The total world production of primary aluminum metal in 1976 was 13.4 million tons, of which North and South America accounted for 35%. In terms of the western world alone, the Americas contributed 46% of which more than 90% can be attributed to the activities of Alcoa, Alcan, Reynolds, and Kaiser. Further signs of this concentration are derived from the fact that 62% of the world capacity in primary aluminum production in 1972 is held by the four companies (Mining Annual Review 1977). In the United States, out of the seven companies producing aluminum, one produces 34%, while three of them account for up to 86% of aluminum production (Kruger 1976).

The platinum industry nearly represents the ultimate in concentration, as of a total world supply of approximately 2.8 million ounces, South Africa alone accounts for about 58%. Disregarding the contribution of the Soviet Union, the contribution of South Africa accounts for nearly 78% of the supply. Of this amount, Rustenburg Platinum Mines, Impala Platinum, and Englehard Minerals Corporation account for more than 90% of the output (Mining Annual Review 1977).

A similar story can be made for the dominance of De Beers in diamond; Amax in molybdenum; and the seven sisters - Exxon, Shell, Texaco, Cheyron Standard, Mobil, Amoco, and Gulf in petroleum; and Union Carbide in manganese.

Given the virtually homogeneous nature of the products at the primary stages of the production process, the mining industry could therefore be characterized by the classic features of pure oligopoly as distinct from monopoly, monopolistic competition and perfect competition. As evidenced from the market shares, there are a few dominant producers in each product group and one should therefore expect the phenomenon of price leadership in such cases, coupled with the characteristic occurrence of the occasional price wars, and short term price instability, as the producers assert themselves in this market structure. Attention will now be turned to some of these latter features which are a direct result of an oligopolistic market structure.

The pattern of prices and its determination by the activities of the various producing and consuming units is very instructive of the market structures that obtain at the primary stages of production. Martin (1967) described the peculiar situation of nickel which maintained a spot price of 35¢[1] from 1929 throughout the depression until 1948. This, he attributed to the tremendous price-setting ability of INCO which by 1929 eliminated most of its competitors in the North American market by a set of mergers between 1900 and 1929. In more recent times (August 1975), INCO announced a raise in price from $2.01 to $2.20, and this was immediately followed by Falconbridge. When in September, 1976, Falconbridge increased its price by 33¢ per lb., the market waited until INCO reacted eight days later by pushing the price 12¢ below that set by Falconbridge. The inevitable result was that Falconbridge and all others subsequently adjusted to the prices set by INCO. It is clear that INCO is a price setter in a market structure that is best approximated by oligopoly behaviour.

Similar behaviour can be demonstrated in the aluminum industry where Alcoa, Alcan, Reynolds and Kaiser are the major price setters. The copper industry, though subject to price leadership, is not as responsive as the nickel and aluminum industries. This is easily demonstrated by the events of June, 1975, when the cut in price by 3¢ of Asarco and Phelps Dodge did not evince an industry wide price decrease. Rather, a range of prices existed from 60 to 65¢ until six weeks after when the price went back to the uniform higher level of 65¢. It is to be noted that the cut was not successful because the other producers could not bring their costs in line with this lower level.

---

[1] - All prices in U.S. dollars

In the platinum industry, Rustenburg and Impala are clearly the price setters, as the price increases announced by Rustenburg in June, 1976, were soon followed by Impala and the rest of producers. In the market for ores, the price tag that a deposit will carry is invariably determined by the major firms regardless of whether the discovery was made by itself or by smaller groups.

Thus far, the impression may have been made that the market is controlled by an independent set of large firms whose actions in terms of strategy and pricing are guided generally by a dominant leader acting relatively independently of the others. This, however, is quite fallacious as an intricate, connected web of corporate ownership has resulted in what can best be described as megaconglomerates. These conglomerates are present both within and across commodity groups, thus wielding enormous powers at all levels of industry structure, and their influence is compounded by the fact that they also represent centres of mining finance. A few examples will demonstrate this interconnectedness.

Anglo American Corporation - the largest South African mining finance house, can be considered to have a great degree of control on the free world supply of gold, diamonds, and platinum through its affiliates Anglo American Gold Investment Co. - (Amgold), Anglo American Investment Trust (Anamint), and Rustenburg Platinum Holdings respectively. Its near monopoly control of platinum is accentuated by its 30% holdings in the other major platinum firm of Englehard Minerals and Chemical Corporation via its Mineral Resources Corporation (Minorco). Other major interests of Anglo American are: (a) 35.8% share in Hudson Bay Mining and Smelting Co., (b) 10% share in Messina Development, (c) 30% holding in Botswana RST, (d) 29.98% of Zambian Copper Investments which in turn holds 49% of Nchanga Cons. Copper Mines and 12.25% of Roan Consolidated, (e) 12% interest in Inspiration Copper, (f) Coal holdings via its Anglo American Coal Corporation which controls in excess of 30% of South African coal output (Mining Annual Review 1977). In all, Anglo American holds investments in 14 gold, 14 coal, 8 diamond, 5 nonferrous, 14 prospecting, 9 other mining, 7 land and real estate, 23 industrial and 30 investment companies, which may or may not also have holdings in Anglo American and its subsidiaries (Kruger 1976).

The American based companies of Asarco and Amax reveal similar patterns. Asarco, which is essentially a base metal smelting and refining concern, and whose principal product is copper, owns 49% of MIM Holdings, 52.3% of Southern Peru Copper, 34% of Industrial Minera Mexico, 33.4% of Revere Copper and Brass, and 51.8% of Neptune Mining. There are numerous other mining holdings, the most significant of which is its 50% interest in the currently idle Newmont managed Granduc copper mine. Amax, which derives approximately 40% of its gross earnings from molybdenum; nickel and specialty metals, has substantial relationships with other mining concerns. It jointly owns Anamax Mining Co. with Anaconda; owns 30% of Bamangwato Concessions (BCL) which produces nickel and copper in Botswana, and jointly owns with Homestake, lead-zinc deposits in Missouri. It has a 75% interest in a joint venture with INCO for lead-zinc-copper development in New Brunswick, and 25% in the iron ore concern at Mt. Newman in Australia. It has aluminum interest in Alumax, potash interest at Carlsbad, New Mexico and Saskatchewan, and owns 20.4% of Zambian Roan Consolidated Mines, 29.6% of Tsumeb Corporation, 17.3% of O'okiep Copper Co., 29.8% in BRST, 10.65% of Imetal, along with a joint venture with its subsidiary SLN in Ni laterite production. Imetal is a French-based holding company which owns 50% of Ste Metallurgique Le Nickel (SLN), 58.5% of Penarroya, 93.8% of Mokta, and 67% of Copperweld Corporation. Newmont Mining Corporation is a diversified mining and finance company which is principally involved in copper. It wholly owns Magma Copper Co., Similkameen Mining Co., and Granduc Co., while participating 57.5% in O'okiep Copper, 29.6% in Tsumeb, 28.6% in Palabora, 23% in Bethelem Copper, 39.6% of Sherrit Gordon Mines, and 10.7% of Southern Peru Copper. In other operations, it wholly owns Carlin Gold Mining, Resurrection Mining, Newmont Oil, and has 80.1% interest in the now idle Idarado Mining, 51% in Dawn Mining, and 3.3% in Continental Oil (Mining Annual Review 1977, Co. Annual Reports).

The documentation could conceivably continue ad infinitum, but it is not necessary for the present purposes. Enough has been said to demonstrate that independence and non-collusion may not be the norms in the mineral industry. Rather, it is to be expected that there could be a great degree of collusive activity on the part of the corporations to influence investment, output, and prices. The crisis of copper in 1977 is instructive from the standpoint that one of the major reasons for the continuing inventory accumulation, and its downward pressure on prices must be attributed essentially to the large influence of the state-run and state-manipulated sectors which have other responsibilities such as maintenance of employment levels, acquiring of foreign exchange earnings to aid their debt ridden countries, instead of price maintenance by production cutbacks.

Collusive activity in output restriction obviously has been unable to stem the demands for foreign exchange with the result that the state operated enterprises in Chile and Zambia have attempted to increase production while the major private companies are continually seeking measures to reduce output and control prices (Mining Journal 1977). In the case of nickel where private operations are dominant, the industry has reacted in perfect unison by cutting production to maintain prices as evidenced in the recently much publicized intentions of INCO to lay off 2800 workers at Sudbury, and similar actions by Falconbridge Canadian operations.

At the distribution stage of primary mineral products, the producers themselves account for the largest share of outlets. Of the 41 mineral and metal products investigated by (Kruger 1976), 46% of the outlets were by the producers themselves, 18% were captive outlets, 28%

were by merchants, and 8% by others (see Appendix 9). The figures would indicate that approximately 64% of the outlets (producer and captive) were directly tied to the mining and smelting concerns. When one considers that many of the major merchants are intimately connected in the corporate web that envelops the mining concerns, then it is evident that the 64% direct control of outlets understates the vertical integration of the mining industry. For example, the extremely large Philipp Brothers is a part of the Anglo American network through the merger of the former with Anglo American controlled Englehard Minerals and Chemical, while the second largest merchant group in the United States - Continental Ore and Chemicals - is a part of the International Minerals and Chemicals.

Appendix 10a, 10b, and 10c demonstrate one of the direct consequences of the concentration that occurs in the mineral industry. In Appendix 10a, the reserves-output ratio and the resources-capacity ratio of the nickel industry are calculated with respect to the various countries. The figures reveal that reserve-output (R/O) ratio for the world was 82.4 in 1973, while the resources-capacity ratio is 104.1 given a 1980 capacity of 1,183,000 tons nickel. The highest R/O ratios are evident in New Caledonia, Indonesia, Australia and Cuba which have reserves that are greater by 239,217,125 and 97 times than their output levels. Appendix 10a shows the R/O ratios for the most important molybdenum producer, Amax, and once again the extremely large reserve to output ratio of 56 is evident. For the

Noranda Group of companies (Appendix 2c), a more diverse range is depicted. However, it is still to be noted that four of the ten companies listed have R/O in excess of 20, with Central Potash Limited in which Noranda has a 51% interest, carrying a R/O of 216. Such large asset to output ratios separated the mineral industry from other forms of economic activity where smaller asset-output ratios are held. Martin (1967) has estimated that U.S. Steel is even more capitalized than the giant of multinationals - General Motors.

While the definition of assets in the case of the mineral industry and other forms of economic activity may not coincide exactly, one can reasonably assume that the cost values of the proven mineral reserves held, given a rate of discount equal to the current rate of interest, are far out of line with sales and output levels in the industry for reserves in excess of about 20 years. An argument can conceivably be made for over investment in some sectors of the mineral industry, while administered undercapacity of production facilities may be equally present because of the oligopolistic market structure. It must be recognized also that there is no empirical evidence to suggest that the proven reserves could be economically produced under larger world sales regimes, hence over investment may be the operative phenomenon.

Sources of Concentration

The sources of market imperfection and the tendency to concentration were at first intuitively attributed to the physical and locational attributes of the mineral resource which conferred on it some degree of exclusivity. Apart from these, it must be recognized that mineral projects typically have long lives, and consequently capital maturation is achieved over a protractedly long period of time. Typically, the time from exploration to extraction can last in excess of ten years, and it is only at that point that returns are realized. There are only a few concerns that would immobilize their assets, along with the carrying charges, that long. Thus only the large, financially capable firms with their access to both internally generated funds, and external capital will be able to see the process through from the exploration to extraction stages. Large tracts of land and the right to them must also be secured before these sums are expended, and as Seagraves (1967) pointed out, these very rights are to be considered as a scarce factor of production, and ownership to them confers a monopoly power over its subsequent disposition.

Another source of market concentration may be attributed to the need for capturing the economies of large scale production and administration. These economies may be derived essentially on account of indivisibilities in equipment, or from the advantages of a large and well equipped management team. Appendix 11 shows typical economies of scale that operate in the copper industry at the different stages of production. It is seen that at the mining stage, an increase in capacity by six times increases capital investment requirements by nine times while reducing operating costs (direct, indirect and fixed) by approximately 50%. These are distinct economies of scale, but they start to decrease after certain sizes as revealed by Adelman (1964) in the case of oil. This optimum level of operation seems to be constrained by an optimum level of management efficiency, coupled with rising physical and user costs as described by Scott (1955).

Typically, concentration is accompanied by vertical integration in the firm, which attempts to capture the economies that are available at all stages of the production process. However, the limits and finiteness of ore bodies pushes these integrated firms to further control their own sources of supply, since cornering deposits ensures its own survival while it precludes prospective competitors. Naturally, there is a tendency for overmotivation of exploration activity as evidenced by the ridiculously high reserve to output ratios held by some firms, and herein lies another source of increasing cost beyond a certain size. So pervasive and entrenched is this requirement to secure ones own source of supply, that it led Martin (1967), who studied the behaviour of the iron, molybdenum, nickel, gypsum and lumber industries, to conclude that the "differences in the structure and control of individual markets might be explained better by the structure of control of necessary basic resources than by economies of scale at the product level of production". In the case of the steel industry, Martin asserted that there was a positive relationship between the opportunity of a firm to compete for an expanded share of the steel market, and the control of the supply of iron ore, but the direction of causality is not clear. For all the minerals he studied, he postulated that there is a tendency for concentration in strong hands of deposits whose liquidation date lies far into the future.

A closer look at Martin's data on the eleven steel firms he investigated, reveals that Inland Co. and National Co. operations represent a near optimal size as defined by the rates of return on sales, assets, worth, and capital expenditure. It may be significant that these two firms, Inland and National also carried reserve/output ratios of 20.7 and 20.2, which is considered as the limit of valuable assets given current rates of discount. It is also obvious that large size is no guarantee of maximum rates of return, and this view is also supported by the 1970-1976 Canadian Mining Statistics which show that the large integrated companies like Cominco, INCO, and Noranda obtained rates of return on mining operations of 12.1%, 12.9%, and 12.1% respectively, while smaller, more vigorous companies like Mattagami have consistently higher returns (Reimer 1977).

It must be admitted that there are numerous other variables that will affect and determine the returns on net investment and as such, the above are only offered as observations which may be pertinent. However, it may be fair to assume that the larger integrated units may be prepared to accept the diminishing (proportional) returns on capital due to disproportionately large over investment in reserves for the real and imagined benefits of longevity, and a steady income stream. The returns to the larger companies, without a doubt, reveal this relative constancy in the realized returns.

Concentration maintains and perpetuates further concentration, as the credit system is progressively biased towards potential debtors with large assets, while being extremely punitive on first time small debtors. The small company must also be ever mindful of reprisal from the larger companies with its web of connections if it contemplates independent action that does not live up to the expectation of the larger concerns. Galbraith (1971) probably best captured these relationships by describing these large integrated units as having "a common strategy which requires that the market be replaced by an authoritative determination of price and the amounts to be sold and bought at these prices."

The obvious conclusion of the preceeding section is that the mineral industry at the levels of ore acquisition and refining is pervaded by pure oligopolist tendencies. The argument is made that the industry manifests large degrees of vertical and horizontal integration, with the latter resulting in a corporate megastructure which may necessarily lead to some degree of collusion - albeit of different states of perfection - depending on the specific commodity and economic circumstances. Any attempts at entry by other groups, whether as satellitic subsidiaries, or state-operated entities, must come to terms with the pervasive presence, influence, and dominance of the corporate umbrella in the mineral industry.

PRICE STABILITY AND THE COMMODITY PROBLEM

The oligopolistic nature of the mineral markets and the derived nature of demand for mineral products have contributed significantly to the price fluctuations which have become so characteristic of mineral and some primary commodity markets. Widely fluctuating mineral prices result in a very precarious existence for the underdeveloped country, and are a constant generator of tension between sovereign governments and external sources. This section, therefore, addresses itself to the question of price stability and commodity arrangements in so far as they affect the ability of the underdeveloped country to maximize and maintain a predictable income stream.

Appendix (12) shows the fluctuations quite clearly, and they demonstrate that both mineral and non-mineral products share the same fate. It is also instructive that copper which has a fairly large free-market determined price, shows fluctuations of the greatest amplitude, and that of the food products, wheat, which is a major export of the developed countries shows the least fluctuations, while the tropical products (rice and sugar) show large price variations.

The principal reason for these wide fluctuations in price is attributable to the short-term price inelasticity of demand and supply, coupled with low income demand elasticity. The assymmetry noticed in the developed and underdeveloped countries with respect to price fluctuations arises principally from the fact that in DC the level of production is very sensitive and responsive to changes in demand, while in UDC, on the other hand, producers find it very difficult to curtail output as demand falls, because of supply inelasticity. In times of brisk demand, the UDC increase production, therefore, when the recession occurs, demand lags very far behind output, causing prices to fall precipitously. This greater demand inelasticity of the UDC is due essentially to their greater specialization in one or a few product lines. Also, the fact that fewer of their exports are consumed at home or produced abroad in the importing country, caused a reduction in the elasticity of supply in the exporter and of net demand in the importer. In the case of copper, 50% of which is exported from the UDC to the DC where the supply of copper is more elastic, the general tendency is for price ceilings to be set on the exports of the UDC, but of course no floors (Kindleberger, 1964). Within the UDC themselves, instability is characteristically greater in smaller (w.r.t. GNP) than larger economies, reflecting perhaps that smaller economies are invariably more concentrated in fewer lines.

Price instability in primary commodities and the need for its elimination is best viewed against the operative functions of prices in the economic system. Generally, in economic analysis, prices have performed a market clearing function, as the price of a commodity under assumptions of competition, etc., are determined by demand and supply in the short run, and are cost determined in the long run.

However, the threat of shortages and possibilities of market control have established base prices which bear closer relationship to the cost of substitutes rather than inherent supply cost. At the same time, prices are viewed by the underdeveloped world as a sure way of effecting an equality in income distribution, thus pushing the concept of price even further away from the cost plus market clearance concept to a resource transfer concept (Bosson and Varion, 1977). In the specific case of minerals, which trade minimally in free commodity markets, but are rather controlled in vertically integrated companies, and increasingly to a large extent by long-term contracts, it is extremely difficult to distinguish a price that meets the cost plus criterion, but rather a whole range of prices can be found.

Commodity agreements, either in the form of multilateral contracts for purchase and sale at stipulated prices, quota restrictions on export and or output, and buffer stocks, are the principal mechanisms used to effect stability in export revenues derived from individual commodities. The unratified 1948 Havanna Charter of the UN International Trade Organization made the first real effort at commodity arrangements, which were tantamount to licensing of cartel formation for short periods, especially for small producers whose commodities were experiencing "burdensome surplus" and for which corrective action would necessarily mean widespread unemployment and misery. In this mould, commodity agreements were seen by the major consumers in the developed world as attempts to increase price, and transfer resources from consumers to producers. The resource transfer motive can be considered akin to aid, which they argued could be accomplished by more direct and efficient tools. The trend in the 60's and 70's would seemingly confirm the consumer's fears that commodity agreements tend to have a greater price raising role, with stability concerns being relegated to the compensatory finance provisions as indicated in the Lome'Convention and the reorganizations of the IMF compensatory finances (Rogers 1976).

The natural consequence of such general disagreement is that in 50 years, only four agreements (tin, coffee, cocoa, sugar) were concluded, and in three cases, the major importer did not take part. The tin agreement which resulted in the formation of the International Tin Council in 1956 is probably the most effective of these agreements, and promises to be more so, now that the major consumer, the U.S., has joined the agreement. The experience of this agreement reveals that tin buffer stocks which generally net about 8% were not as important as export quotas in price stabilization when excess stocks were present (Singh, 1976; Gilbert, 1977). Though the stocks were inadequate in maintaining the ceiling because they were invariably too small, they were a far more flexible and easily administered mechanism than export quotas. The inadequacy of finance can be attributed to the fact that only producers from the underdeveloped countries contributed to the fund which at its peak was only one-tenth of the total U.S. stockpile, which was the main deterrent to large pressures on the ceiling. In retrospect, therefore, the tin agreement was only successful as a stabilization effort because of the combined effect of its activities maintaining the floor while the U.S. stockpile maintained the ceiling. However, the general lesson which emerges is that export controls should be used in times of an excessive surplus and not for counter-cyclical price stabilization which is better achieved through the buffer stock.

The establishment of buffer stocks involve distinct costs to the producers other than the costs of storage and of carrying the inventory. Radetzki (1977) has demonstrated that for commodities-like minerals with low price elasticities - producers fail to maximize profits by engaging in buffer stock arrangements, instead of simply restricting output and maintaining prices. The low elasticities would result in net losses to producers when buffer stocks are established especially in situations where the installed capacity in the minerals industry is enough to meet boom demands without raising price to the extent where substitution can occur. This tendency on the part of producers to favour production cuts and export restrictions is a typical feature in the "controlled" markets such as aluminum, tin, and to a lesser extent, copper. Buffer stocks are only advisable in situations where marginal cost and storage costs are low, price elasticity of demand is high when stocks are being sold, and the higher the level of demand during the boom. However, the unemployment effects

7

associated with production cuts, plus consumer welfare may be mitigating reasons for establishing buffer stocks instead.

The paucity of commodity agreements and their relative lack of success in stabilizing incomes from primary exports, essentially due to their limited coverage with respect to participating countries and commodities has resulted in a general disenchantment in the UDC for isolated commodity agreements. Rather, they have indicated increasing interest in an integrated multi-commodity approach as noticed in the UNCTAD deliberations of 1974, so that the burdens and benefits of instability can be overcome. Put in this light, the problem takes on dimensions other than price stability, but contains elements of global income redistribution which is envisaged in the new international economic order. The major rationale for an integrated commodity programme ~~is the~~ fact that a group of primary commodities would tend to be more inelastic, hence manipulable in terms of price control, than single commodities. Of course, the larger the number of commodities and hence countries involved in such an agreement, the greater is the possibility that equitable global relations will be established instead of the great capacity for harm to many countries that is inherent in restricted deals. Thirdly, with the use of buffer stocks as the principal balancing mechanism, there could be economy in the commodity management as liquid transfers can be called from the large bank of reserves at various times to support a given floor price when the situation arises. Fourthly, the required indexation is a rather familiar concept in the internal markets of DC who have practised it for a long time, and it offers the possibility for the maintenance of at least traditional purchasing power (Rogers, 1976).

The integrated approach as espoused by UNCTAD has a strong orientation towards reversing the terms of trade deterioration of primary exports, as indicated by the programme of indexation. There are 21 commodities which were considered for the programme, but ten of them are considered as core commodities for immediate attention, as they constitute the principal exports of the UDC. Of the 21 commodities, only six are minerals which are essential to developing countries and for which storage costs are relatively small. Although UNCTAD recommends a ceiling on the size of the buffer stock at U.S. $6000 million, and the Commonwealth Technical Group is lobbying for an initial amount of U.S. $250 million to improve trade procedures, market diversification possibilities, and the development of adequate storage facilities in UDC, the fact that only copper and tin are included in the list of core commodities would indicate that from the standpoint of minerals, price instability will be around for a long time, except if other measures are adopted. One should also recognize that the sums of money mentioned above are far from being realized in view of the major consumers (U.S. and other developed countries) preference for commodity by commodity arrangements and the recent observation that the European powers are attempting to conclude more bilateral arrangements (Mining Journal, October 1977).

The arguments against the integrated commodity approach can be divided into two categories - those inherent in any commodity agreement and those peculiar to the approach itself. All commodity agreements that interfere with the market mechanism are theoretically imposing some rigidity to the system as well as encouraging some inefficiency since the floor price invariably accommodates the highest cost producers. The indexation requirement is extremely difficult to administer as a base must be defined for the assessment of performance, while the variability or stability of this base from commodity to commodity and the measurement of real gains or losses are certainly very difficult problems. The fact that there is need to index specific commodities with respect to other primary commodities and manufactures leaves a lot of room for variation, hence the increasing need for more negotiations. The record of the commodity by commodity approach as far as successful negotiation is concerned leaves little hope for the multi-commodity programme, especially when one contemplates the immensity of the enforcement problems.

Notwithstanding the obvious difficulties of these commodity stabilization agreements, there has been increasing interest by primary producing countries in producer organizations and gentlemen's agreements, which all have as their main aim, price control and supply management. In 1967, the Inter-governmental Council of Copper Exporting Countries (CIPEC) was formed by Chile, Zaire, Zambia, and Peru, and in 1975, Indonesia, Australia, and Papua New Guinea joined them. In April, 1975, the Association of Iron Exporting Countries (AIEC) was formed by Algeria, Venezuela, India, Mauritania, Chile, and Peru. In that same year, the International Association of Mercury Producers (ASSIMER) was formed by Algeria, Italy, Mexico, Spain, and Turkey. In March, 1976, the International Bauxite Association (IBA) was set up by Australia, Guinea, Guyana, Jamaica, Sierra Leone, Surinam and Yugoslavia, with Haiti, Dominican Republic and Ghana joining later. Talks were conducted on lead, zinc, manganese, and tungsten with similar intentions (Bosson and Varion, 1977).

These attempts by producers to form groups which would allow them to derive the maximum gains from their commodities have been obviously inspired by the ability of the OPEC countries to significantly increase the price of oil in 1973 and later years. The question then reverts to an assessment of the conditions most likely to facilitate the creation of a successful cartel, since the OPEC cartel has certainly enforced strong income redistribution forces in the oil producer's favour.

The obvious controlling mechanism for the creation of a cartel is a communality of interest among the various participants, as any forced manipulation of the market mechanism must be accompanied by the power to do so. This power becomes even more meaningful if the opponents are fragmented and if there is a good flow ~~of~~ information among the cartel participants. Naturally, solidarity is difficult to achieve in any system of forced restrictions especially since the fear of everyone being made worse-off by a breakdown of the cartel is not as great as the temptation of the gains to be had by cheating (Streeten, 1976). In times of surplus stocks, when prices can only be maintained by restricting output, the temptation to cheat is overwhelming, as individual self-interest transcends the group's interest. In boom periods when stocks are reduced, prices are firm, capacity is increased, and income is good, there is no need for a cartel.

The participating member states in a cartel-like arrangement must all exhibit a certain degree of resilience in accommodating reductions in income as well as a near equality between their cost structures, as disparities can only lead to internal tension (Persaud 1976). Their inter-temporal preferences for the benefits of the association must be synchronized as those seeking short-term gains may well do so at the expense of the long-term future viability of the cartel, and eventual disaster for all. Similarly, there must be an equitable distribution of the gains from cartellization, coupled with attempts by the group to accommodate the various absorptive capacities of the respective economies, so that the disequalizing effect of inflation, etc., can be countered. Even if these preconditions are available, the arrangement becomes more operational when a system of rewards and penalties are set up. The group's interest is best met by fostering competition among consumers, and by playing one group against the other, as the OPEC nations did by boycotting the U.S. and Holland while supplying Britain and France. This objective will obviously be part of a larger strategy to account for any form of retaliation that may occur.

The economic variables that facilitate effective cartellization are:

(i) Inelasticity of demand coupled with inelasticity of supply in response to higher price in the medium and long term.

(ii) The essentiality of the good.

(iii) A high income elasticity of demand.

(iv) The ease of control of production

(v) Low storage costs.

The price inelasticity of demand depends on the proportion of imports to the consumption of the commodity in importing countries, coupled with a low elasticity of substitution and few substitutes. The higher the import content of the commodity and the lower the elasticity of substitution, and amount of substitutes, the more inelastic the demand will be, and the greater the cartellization potential of the commodity. Supply inelasticity is increased if there are only a few countries among which there is a great degree of solidarity, and in which all close substitutes are produced. Production restrictions may be made very difficult because of labour problems, especially the displaced mine labour which has little alternative but joining the ranks of the unemployed in UDC. The greater the measures to ease this problem, the greater will be the ability of the cartel members to restrict output and maintain price. Storage costs are usually good for metals, but very bad for ores because of their bulk, thus indicating that greater control of the refined metal is a definite asset to cartellization.

From the standpoint of the attempts of underdeveloped countries to redistribute world income through cartel action on the price of their primary commodity exports, it appears that the experience of oil is not about to be duplicated easily. In the first place, the communality of interest criterion is hardly met in most primary commodities especially the minerals. The underdeveloped countries (UDC) account for only approximately 30% of non-fuel mineral exports, therefore indicating that from a global perspective, the developed countries (DC) and centrally planned economies are the major non-fuel mineral exporters. However, unlike the UDC, the DC also have a stake in the level of prices from a consumption standpoint as they consume about 65% of world mineral output compared to the 10% of UDC and 25% for centrally planned economies (Bosson and Varion, 1977). One would therefore expect that the developed countries as a group would attempt to follow policies that would be more stabilizing in nature rather than price augmenting.

A ray of hope for the UDC is that the import content of the developed countries consumption of minerals has increased from 33% to 39% of world mineral output between 1950 and 1970, and it will continue to do so. The corresponding figures for the nine major minerals which account for over 85% of world minehead value, are 44% and 60% respectively. Of these nine minerals (tin, copper, lead, nickel, zinc, iron ore, manganese ore, phosphorus, bauxite, and aluminum), the UDC accounted for 72% of the DC import requirements while Australia, Canada, and South Africa accounted for the rest. However, this must be set against the fact that the UDC share in world mineral exports in the mineral commodities for which they are more favoured is about 60% to 80% for only two minerals - tin and bauxite. Their share of world exports is about 50% in three minerals (manganese, phosphate rock, and copper), and less than 30% in three minerals (iron ore, zinc, and lead).

The best prospects for cartellization, therefore, appear to be tin and bauxite, which have existing producer agreements. However, the past and future performance of these two commodities as successful cartellizable products have been and will continue to be dismal at best on the objective of price increases in an OPEC-like fashion. It is true that bauxite prices have been substantially reviewed upwards in the Caribbean and elsewhere, under the IBA umbrella. However, future rapid increases in price are rather remote since a backstop technology in aluminum production from high aluminous shales is available. Similarly, steel, aluminum, copper, and glass make effective substitutes for tin in its traditional uses.

Speaking glibly of a group identified as UDC conceals the fact that there is hardly a clear identity of interest among the group. Only a few UDC are significant mineral exporters, hence any attempts at increasing mineral prices will ultimately mean a higher import bill for the others, and a deteriorating balance of payments problem. The OPEC oil increase in 1973 was accompanied by an increase on the current account deficit in non-oil producing UDC of $32.1 billion (from a level $7.7 billion in 1973 to $39.8 billion in 1974), (IMF, 1975). Though OPEC-like actions are not foreseeable, it reveals some reasons for disunity among the ranks of the UDC. It is in this light, that an integrated commodity approach is meaningful to the UDC as there is room for more countries to be part of the bargaining process, and thus increasing the possibility for a more equitable and acceptable adjustment. However, one cannot lose sight of the fact that the possibility of agreement varies inversely with the number of participants.

Bosson and Varion (1977) introduce an interesting dimension to the commodity problem, especially for minerals, as they consider that burdening the price mechanism with income redistribution goals may necessarily restrict the flow of investment into much needed mineral exploration. To the extent that the UDC have a known reserves to area ratio of approximately 0.77:1 compared to DC which have a reserves area ratio of 1.35:1, and the fact that the UDC have immense virgin areas yet to be explored, then any attempts at increasing investment in mining will find, through time, a larger proportion going to the UDC. This is obviously a very long-term proposition, and for it to take effect, there will have to be a much greater degree of forebearance and trust, which is obviously at its lowest ebb at the present time. The expectations of the peoples of the third world are more immediate, and the developed world will only grudgingly give up whatever lead it does possess. It is only to the extent that both sides will gain that any acceptable forms of price stabilization and income redistribution, which are inextricably linked, will be undertaken.

The fact that both sides are talking is encouraging, as the flow of information can only increase the appreciation of each side for the other's position. It has also facilitated the groups with a greater appreciation of the interconnectedness of the international economic community, while making them aware of the real opportunities that are available. To the UDC, the move on the part of Canada and Australia in instituting more progressive forms of legislation which limit the profitability of the multinational mineral enterprises, is extremely significant. Moves of this nature, though conceived with their respective self-interest paramount, will certainly augment the flow of investment funds to the UDC. It is only to the extent that such opportunities for increasing income generation are available to the UDC, that pressure on the price mechanism will be reduced, thus increasing the possibility for meaningful stabilization attempts.

CHAPTER FIVE

MINERALS AS A GENERATOR OF ECONOMIC GROWTH/DEVELOPMENT

GENERAL STATEMENT

Underlying the foregoing discussion is the assumption that a specific mineral endowment is an automatic asset to the development process. It is equally relevant and perhaps more interesting to address the enquiry to the question of the role minerals have traditionally played and should play in the growth process. Secondly, the indicators which can be used to identify its contribution must be isolated. Finally, statements concerning the deleterious effects of the mining industry must be made highly explicit, so that expectations can be brought into line with reality, and corrective measures prescribed at a very early stage in the development of a mineral policy.

It is an observed fact that mineral resources are indispensable to the industrial cycle which it partially initiates when combined with a few cooperant factors. Maintenance and perpetuation of the industrial life is often times considered synonymous to preservation of national security which can be loosely thought of as "the capacity of a society to enjoy and cultivate its culture and values" (Cooper 1975). Not surprisingly, therefore, management and control of the nation's mineral resources have been seen as vital security elements in its survival and growth. However, this should not be read as an open endorsement of any form of mineral activity, as the welfare considerations in the security argument must fulfill the criteria of the maintenance of a specific standard of living that is consistent with society's values.

The argument has been made in Chapter 2 that any export-oriented activity will not contribute significantly to development if the returns are spent only to maintain the current consumption. There is need for significant local reinvestment in producing what Schultz (1960) calls "superior forms of reproducible capital." It is no secret that in many cases the world over, mineral development has not resulted in long-term human development, as can be evidenced by the frequent juxtaposition of abject poverty of the masses on the one hand and excessive wealth of a few on the other; not forgetting the degree of human misery that follows in the wake of an exhausted deposit. Kuznets (1960), however, perhaps captures the mood and reality of the potential for development in small countries endowed with a limited range of natural resources by his trite comment that ".....The existence of a valuable natural resource represents a permissive condition, which facilitates - if properly exploited - the transition from pre-industrial to industrial phases of growth. But unless the nation shows a capacity for modifying its social institutions in time to take advantage of the opportunity, it will have only a transient effect. Advantages in natural resources never last for too long - given continuous changes in technology and its extension to other parts of the world."

Regardless of one's political philosopy, a strong case can be made for the coincidence of demand for and supply of any good, coupled with the increasing involvement of all sectors of the economy. Joseph McCaskill - a former Assistant Secretary of the Interior of the USA (1960) - made the rather cogent observation that "one of the reasons mining in the past has not contributed more to development of the country is that the material being mined is not used by its citizens. If people are to develop - not just acquire a little more food, clothing, and shelter - but find a higher and richer level of living, they must experience a greater involvement than is found in an ordinary day's work in the mine when they never see the end product of their labours."

INDICES OF PERFORMANCE

Intuition and a-priori reasoning is not a sufficient basis for prescription, and one must address the questions of the value of the mineral resource as a factor of production, as well as their contribution to economic growth in poor countries. Baumol (1951), as part of the classical tradition, attributes a dominating role to natural resources while the neo-classicals as evidenced in the Harrod-Domar schema, assign very little significance to natural resources because they appear quantitatively insignificant compared toother sectors in a national accounting sense. The resolution of these disparate views must explain the significance - if any - of the observations that: (a) a cross-sectional study across countries indicates that natural resources as a proportion of national income seems to be higher in poorer countries than in more developed ones, (b) as per-capita income increases, natural resources characteristically contribute a declining proportion. Schultz (1960) has set the upper limit of 20 to 25% as the contribution of natural resources to national income in poor countries, and approximately 4 to 5% for their contribution in developed countries. Bosson and Varion have shown that in the DC, the share of the non-fuel mineral sector in GNP fell from 0.72% to 0.66% from 1960 to 1970, while in the UDC, it increased from 1.1 to 1.2% over the same period.

Are these observations to be interpreted as signifying that natural resources are a drag to economic growth? At least, superficially it has been interpreted that way by some. Schultz relegates the observations to the higher rates of return that can be obtained in secondary activity, coupled with the declining value of natural resources at factor cost compared to the aggregate value of all other resources. This decline was attributable to technological progress and substitution possibilities a la Barnett and Morse (1963), Nordhaus (1974). In this context, economic growth represents "a form of dynamic disequilibrium brought about by the introduction of new and superior resources" which according to Schultz leads to the apparent decline in importance of natural resources.

Abramovitz (1960), however, would only accept with some reservations, Schultz' emphasis on the dominance of declining resource value. He views the connection between resources and growth via income, savings, and investment as being a rather tenuous and indirect one, and prefers to address himself to the question of whether differential endowments have definitively lead to differential growth among countries historically. Though there seems to be some correlation, Abramovitz contends that it may not even be relevant to the underdeveloped countries who have a different set of values and sense of history. He would go only as far as saying that "natural resources have contributed to differences among the rates of growth of those countries that have been prepared to make good use of their resources, natural or otherwise." The obvious inference, and one that bears much weight is that the development factors must be found within the institutions, and the socioeconomic environment of the country.

Dales (1960) completely denies the importance of the ratio of contribution of natural resources to total output as a measure of sectoral importance. He sees it simply as an arithmetic relationship which will be large or small depending on the size of the numerator and denominator. It is theoretically possible to obtain a situation where both high and low ratios can mean great importance. The low ratio could reflect a situation where a mineral deposit is abundant and easily worked, thus freeing scarce resources to be used elsewhere with the concomitant increases in output. Certainly, this reflects an important sector. The high ratio, which was interpreted as great importance, could represent a case of high-cost extraction which would not only increase the numerator but decrease the denominator as well. Certainly, this situation cannot be considered as being conducive to growth.

Location theory offers an alternative in assessing the importance of a natural resource or mineral endowment to economic growth especially if the question is posed in terms of why growth here rather than there?. In this way, the specific contribution of the mineral resource will be identified. One will necessarily have to take account of the physical amounts of the resource, its quality, and ease of recovery in terms of accessibility and transport costs. Naturally, as Dales points out, the importance of resources to economic development "....depends directly on the physical quantity of resources used in the process of production and inversely on the cost of transporting the resources from one area to another." This approach will be utilized in the evaluation of the developmental prospects of specific mineral resources in Guyana.

ASSESSMENT OF IMPACT OF MINERAL INDUSTRY

From a developmental standpoint, the economic impact of the mineral industry has been traditionally evaluated with respect to its direct contribution to national income via its output, contribution to exports, wages and salaries and taxes. Some attempts were made to assess the derived effects which were a consequence of the purchases of the mineral industry from other sectors of the economy (backward linkages) and the amount of mineral output that finds itself into further processing (forward linkages), which are assessed by the value added (that is, wages, profits, rents, etc.) in each subsequent processing stage. The forward linkage effects are much more superior to the backward linkages in the mineral industry, but as Schramm (1970) points out, care must be taken to ascertain that a true linkage exists. (The test of a true linkage is to ascertain that the activity would not have occurred in the absence of the mining venture.)

The magnitude of these linkages at various stages of production varies from one mineral commodity to another, but generally there appears to be a significant increase in value added from the mining to the fabrication stages. Schramm, using figures generated by Stahl (1973), shows that for the Canadian economy, each additional dollar's worth of output of the metal-mining industry generates $2.70, going as high as $4.71 at the fabricated stage. Girvan (1971) demonstrates that the transformation of a ton of bauxite into semi-fabricated aluminum increases the value from approximately $14 to about $350. The immediate implication of these figures is that the major contribution to income and employment generation is to be found in the later processing states. However, one must not lose sight of the fact that the processing stage is invariably very capital intensive, so in the pursuit of employment objectives this must be taken into account. For example, in the aluminum industry, the capital investment requirements per metric ton of annual output is approximately $25 to $30 for the bauxite mining, $200 to $300 for the aluminum smelter. (Bosson and Varon, 1977). The central point is that the efficient allocation of scarce capital resources must be borne in mind at all times, as development that fosters greater concentration of wealth within the country may in some cases be worse than no development at all.

Another interesting approach to assessing the impact of the mineral industry was developed by Boadway and Treddenick (1977) who looked at the impact of mining on the Canadian economy. Essentially, they utilize a comparative static analysis on the changes that occur in the economy with and without specific or all the mining sectors. In this approach, the impact on the wage rate, interest rate, foreign exchange cost and level of trade are determined. Though their study is specific to the Canadian case, their results are instructive in a greater appreciation of the likely impacts that can be expected in mineral related developments.

Under the assumptions that no mining occurred in Canada, and that all the capital and labour displaced are available to the economy, some interesting results were obtained. Basically, those industries that were suppliers of input to the mining industry and those depending heavily on foreign exchange to meet their import requirements were severely affected. The industries in order of decreasing impact are services incidental to mining, utilities, construction, education, hospitals, health, rail transport. Most favoured in the absence of mining were the capital-intensive industries which in order of decreasing activity were petroleum refining, machinery, petroleum and gas wells, motor vehicles, aluminum rolling, miscellaneous manufacturing, iron and steel, rubber, and metal fabricating. The higher price of foreign exchange due to the lack of mineral exports and the increasing import bill causes (a) other export industries, particularly if they are capital intensive, to be favoured. (Of course, if the other major exporting industries are labour intensive, then the effect of an increasing wage/rent ratio will nullify some of the effect of the increasing exports). (b) attempts at import substitution. Of particular significance is the fact that in the gold, coal and lime industries, the wage/rent ratio actually fell perhaps reflecting the generally lower capital/labour ratios that exist in these areas.

In the more realistic situation where it was assumed that the capital originated from abroad and that it was not available to the home market in the absence of mining, it was seen that exchange rate changes were more significant than wage/rental ratios in fostering specific industrial groups. The exchange rate rose as before, but not to the same degree due to the retarding effect of a lower wage/rental ratio which encouraged labour-intensive exports and import-competing industries. Generally, the effects on specific industrial groups were rather similar to the case where the capital was available to the rest of the economy. In this case, however, the welfare index falls much more than in the case where the capital is retained, though the absolute fall of the index in both cases was relatively negligible. This relatively negligible decline in welfare is attributed to the integration of the Canadian mineral industry in world trade. The effect of specific types of industries on welfare bear testimony to this integration, as welfare generally fell for the decreasing activity in the usually non-tradable industrial minerals such as gypsum, asbestos, quarries and sandpits, and iron, while it actually increased when metal mining operations were removed.

The case of an expansion in the mining industry occasioned little surprise in terms of its effect on the industrial groups, when the assumption of a fixed capital and labour supply were assumed. Increasing activity in mining released more labour relative to capital in the rest of the economy so that wage/rental ratio falls in the rest of the economy while it rises in the mining sector. Glimpses can be now had at the polarization and dualism that are so prevalent in poor countries which have dominating mineral sectors. Apart from the negative effect on wages outside of the industry and the non-availability of capital to other forms of capital-using activity, mineral expansion is typically followed by currency appreciation which augments the level of imports, and the concomitant immiserizing effect of the dependency that follows in its wake, especially in the "bust" years.

THE SOUTH AMERICAN EXPERIENCE

The South American experience with the mineral industry has led many students of the industry to seriously question its very relevance to the development process. Undoubtedly, mining has been the principal source of foreign exchange earnings for many South American countries, as evidenced by the following rather high figures (approximately 80% of Bolivian foreign exchange earnings; approximately 50% of Guyana's exports, approximately 56% of Peru's foreign exchange earnings (Page, 1976). However, Page demonstrates that the majority of these earnings are spent by the mineral sector, and not by other sectors of the economy. This certainly does not lead to meaningful development. Page also demonstrated that though on average the gross contribution of the mineral sector to government revenues in Chile, Bolivia, and Guyana, was about 13%, the net contribution after making allowance for government services such as ministry of mines, geological surveys, schools, etc., will be significantly less.

With respect to the objectives of job creation, minimizing capital requirements, and helping to create an egalitarian society, it seems as though the mining industry has failed once more. In Guyana, Peru, Chile, and Bolivia, less than four per cent of the population is engaged in mining, which is experiencing significant new capital investments in the respective countries (Guyana's Guymine, $350 million; Chile's Codelco and CAP $550 million; Peru's state owned companies $4000 million). It is estimated that capital costs per head can easily lie in the range of $100,000 to $200,000 and this can certainly be contrasted to the ILO figures of $25,000 per head in animal and vegetable oils and fats, $3,200 in leather and $4,680 in agricultural machines (Page, 1976). With capital requirements of these magnitudes, it is certainly very easy to envisage the subsequent polarization of the social structure that will ensue, as strong, well-paid, conspicuously-consuming mining groups develop at the expense of a continuously immiserized subsistence sector. Social dualism will reinforce the economic dualism in a reciprocal perpetuating fashion if left to the free flow of the market process. Added to these failures where they should have been pluses, is the dehumanizing social decadence that is so characteristic of mining towns (Grant, 1971).

The impression is clearly made in the latter sections that mineral based growth as it exists in South America, and perhaps most underdeveloped countries, has "created an economic and social structure ill-prepared to cope with the exigencies of modern industrial development" (Grunwald, 1964). The fact that they are export oriented has left their imprint on the physical and eco-social development of the country. The location of the deposit which invariably is in some remote area of the country determines where the principal physical infrastructure will be built. Invariably, the roads, railways, etc., will describe a straight path to the nearest port where the minimum of necessary facilities will be located. Because of the export orientation and relative isolation (physically, economically, and socially) of these mineral based activities, there is an extremely weak economic link with the rest of the country, and they have "remained as enclaves, better integrated with the outside world than with host economies" (Girvan, 1976, 1970).

The failures of the mining industry, so enumerated, leave very little to recommend it as an agent of development. However, it is absolutely necessary that one isolates the situations that are structurally controlled (that is, intrinsic to the industry) as opposed to those functionally derived from conscious policy decisions. Without doubt, the exhaustible, capital-intensive nature of mineral deposits are obvious contributors to some of these deleterious effects noted. At the same time, there is a strong feeling that the historical ill effects of mining can be largely attributed to inappropriate government action in not seizing the opportunity of converting the potential wealth inherent in mineral deposits into real wealth. In many situations, a strong case can be made for the misapplication of the proceeds from mining as a major contributor to the dualism, and the dependent underdevelopment that arises, therefore indicating that greater attempts have to be made in dealing with these controllable variables if development is to accompany alienation of the mineral resource.

FOREIGN INVESTMENT AND THE STATE

The question of the allocation of factor inputs and the application of the proceeds from mining into meaningful development, presupposes that the state apparatus is developed enough to exercise at least indicative control on the activities of all economic sectors. But this is certainly questionable in mineral-oriented activity in small countries where there is an equally relevant and powerful form of economic organization represented by the vertically integrated transnational enterprises (TNE). While Demas, Kuznets, and others concentrate on the nation state and the regional area as the relevant units of study in the development process, Girvan (1970, 1976) argues that the corporate economy is the relevant unit of economic organization that explains the dependent underdevelopment of mineral-export economies.

The transnational enterprise (TNE) is a corporate or non-corporate geocentric concern which controls assets - factories, mines, sales, and other offices - in two or more countries (U.N., 1973, 1974). It is apparently a logical extension of the vertically and horizontally integrated firm into the world arena, where intense competition forces it into greater acts of concentration and market-cornering. This phenomenon was briefly described in the preceeding chapter and some tentative suggestions were made as to the rationale for integration and market control. In this section, emphasis will be placed on the operations of these entities, and their effect on the host countries in which they are resident.

Characteristically, TNE are dominated by a set of large size firms which have annual sales of hundreds of millions of dollars, and which have seen their most rapid growth in the post-war period with the reconstruction of W. Germany, emergence of Japan as a major economic power, and the strengthening of the United States as the major capital centre of the western world. Their growth pattern in the last decade is revealed by the fact that investment by TNE increased 15 times, 10 times, 3 times and 2 times when the originating country was Japan, W. Germany, United States, and United Kingdom respectively. Their home bases are typically in developed market economies of which those based in the U.S., W. Germany, U.K., and France accounted for 75% of all foreign affiliates. The United States is undoubtedly the principal home country as it accounts for over one-third of all foreign affiliates while possessing eight of the ten largest TNE in the world (U.N., 1973). In 1971, less than 300 U.S. firms accounted for over 70% of all the foreign direct investment originating in that country. In the U.K., a comparable figure is indicated as 165 firms account for over 80% of the foreign direct investment (FDI) emanating from that country.

Within these groups, the affiliates operating in natural resource sectors are generally larger than the manufacturing and service concerns and it is certainly significant that though decreasing, about 50% of all FDI in underdeveloped countries is in extractive industries.

This current decrease perhaps reflects a shift to lower-risk manufacturing and services. As of 1971, the sectoral allocation of this investment is 40% petroleum, 9% mining, and 27% manufacturing in UDC, compared to 24%, 5%, and 47% respectively in developed countries (U.N., 1973). The bulk of the research and development (R & D) in these sectors occurs in the home country, which in the case of the U.S. in 1966 accounted for over 94% of all R & D. In the same year, 13 UDC representing 65% of the total UDC population and 56% of the GDP of all UDC paid approximately $1.5 billion which is more than a half of the flow of FDI to UDC, for the access to these technologies in the form of patents, licences, trademarks, etc. These payments are increasing at a rate of approximately 20% per annum and are becoming an increasing proportion of the export earnings of UDC (U.N., 1973).

Most foreign affiliates are either wholly owned or majority-controlled as shown by the fact that at least 80% of U.S. and 75% of UK affiliates are in either of these categories. A notable exception is the Japanese pattern of control which favours minority ownerships along with detailed management contracts, and other stipulations. A notable fact of the TNE is that their ability to borrow locally in their host countries, puts under their control vast financial resources which contribute to greater asset creation locally. The subsequent income stream can be quite large as revealed from the fact that in 1971, the U.S.-based TNE invested $4.8 billion abroad and received as inflow into the U.S., approximately $9 billion in interest, dividends, royalties, and management fees.

Foreign direct investment has certainly replaced the traditional portfolio investment which was so common in the pre-World War II period especially in the relationship between colonial powers and their appendages, as witnessed in the experience of Canada, and the Caribbean (Wilkinson, 1968; McIntyre, 1972). However, at this point it is instructive that three distinct forms of direct investment with different ownership ties and effects on the host economy be recognized.

The first two are "Settler-type" investment and "Putting-Out" investment (McIntyre, 1972). In the former case, the investor and his capital migrates to the territory into which it becomes integrated, leaving no obvious connection with its external origin, except via its consumption pattern and investment in foreign securities which is a normal item in their portfolio. The operations are generally of a smaller scale than resident foreign firms, but generally larger than local firms. "Putting-Out" investment is normally associated with a case where ownership and control resides abroad, but without any visible or other links to a trans-national enterprise. The decision on the input and output mix, along with level of sales and prices are made by the non-resident.

The third form of foreign direct investment is the trans-national enterprise (TNE) which accounts for the

Q

greatest part of private long-term capital movements and trade in commodities. The majority of this trade is essentially in the form of intra-branch transfers, and it is growing faster than world output. Investment by the TNE represents an organic link between the enterprise and the host country as the entire corporate productive apparatus in terms of its technology, skills, management, and financial resources, are transferred to the host. Technological leadership coupled with the setting up of branches behind natural or artificial barriers has been one of the key instruments of warding off its competitors, while generally using the vehicle of advertising to create an homogenized market. Decision-making is internalized within the corporation and control is established over the labour and capital markets. This control is further reinforced by its isolation via the route of internal financing. At the output end of the production process, taste-creation is central to the strategy of the TNE, and the sovereign consumer may really be a relict of the past (Levitt, 1968). Quite noticeable also is the rise to prominence of the "faceless" management team instead of shareholders as the principal decision-making unit of the enterprise.

Unlike the first two methods of FDI, the decision to invest in a particular country by the TNE may be guided by other than the profitability of the said operation. Rather, the foreign operation is viewed by the management team as a link in the global operations of the company, and not as an end in itself, while considerations of the security of supply, resource control, competition reduction, market share or even political influence may be equally strong motives for a decision to invest. The global profitability and possibly longevity of the TNE is the central area of concern, and all local operations are considered "profitable" only in as far as they contribute to the specific objective set for them in the larger corporate strategy, thus subordinating the interests of the subsidiary to the corporation as a whole.

Using the mineral industry as an example, Girvan (1970) demonstrated why the functioning of the corporate economy is central to the issue of dependent underdevelopment in mineral export economies. Basically, by a process of planned incremental displacement, the corporation decides on which raw materials and end-products emphasis should be placed, depending on the growth possibilities of the entire enterprise. The mine in the UDC is considered as a field unit which receives from the parent instructions with respect to the level, nature, and destination of output coupled with the goods, sales, and rent paid by the parent for local purchases. It provides the parent with raw materials, and information while receiving directions for its pricing and reinvestment decisions. With such complete control over the input, output, and reinvestment decision of the most important sector of the local economy vested in the hands of the corporations, one must agree with Girvan that the corporate economy in these cases may be the relevant area of scrutiny for solutions to dependent underdevelopment in economies with dominant primary producing sectors.

More often than not, the goals and objectives of the corporate economy are in direct contradiction to that of the host, which is at the complete mercy of the former especially in exhaustible extractive resources. Naturally, the objectives of the government are concerned with increasing the standard of living of its citizenry, through the exploitation of the resource, while diversifying its economic base to make allowance for its ultimate exhaustion. The corporation, on the other hand, is concerned with its own survival, which is invariably at the expense of the local economy. Obviously, a rational decision by the corporation to shift its end-product and raw material supplies from one low-growth or politically unsatisfactory area to a high-growth or politically satisfactory region can spell virtual disaster for the deserted country, which may have absolutely no influence on that decision. Invariably, the mine is only a small component of the corporate economy and this obvious asymmetry in the level of dependence of the corporate and national economies on the specific mine is obviously a tremendous weapon in the hands of the corporate economy when bargaining is initiated to either enter a host country or to correct whatever deleterious effects may accompany the corporation's presence in the local economy.

The integration of the subsidiary in the global enterprise to which vast capital resources (both internal and external) are available has perpetuated a capital intensive form of investment in areas which are typically labour abundant. Added to this non-concern for the prevailing factor proportions, the high degree of repatriated revenues, and the low quantum of local purchases have all contributed to the non-transmittance of their growth to other sectors of the economy (UNCTAD, 1972). One must also recognize that the contribution to the host economy via taxes, etc., are directly under the control of the corporate head office which decides on the factor cost and level of output that must be imputed to the subsidiary by means of its pricing and other accounting measures.

Given the possibility of a divergence of interests between the corporate and national economies, it then becomes an imperative for the local economy to determine as far as possible the social benefits and costs that are attendant to any specific investment project. The obvious benefits of the FDI are their direct contribution to the conventional growth indices such as increased production, incomes, employment, level of exports, government revenues and to the transferrence of managerial and other skills consistent with the advanced form of technology. However, as indicated in several sections above, gross figures of this nature considered in isolation may conceal some rather serious social costs.

Reference has been made to the enclave nature of the investment where little internal interdependence and a low local value added component exist. The capital intensive nature of the investment which may be very relevant to the home country factor endowments will often times cause a lower impact on employment in a labour abundant economy, while the high wages paid a small local group would only accentuate income disparities, and eventual social strain. Instead of the activity of the TNE complementing local initiatives, it is very possible that local firms can be displaced through their inability to compete not only in production, but in the very local market for credit. Obviously any tendency on the part of the TNE to borrow capital locally, reduces the initial foreign exchange contribution, and may even draw on the scarce foreign exchange reserves of the country when the amounts borrowed exceed the purely local content of the investment. In the mineral sector, where individual markets are uncertain, prices too low to cover heavy capital costs, and the large corporations control the terms of sale of raw materials, the small independent local entrepreneur must confine his activity to the riskier drilling, prospecting, and marginal operations because his credit rating is all but non-existent at the banks. In such cases, the deleterious effect of foreign investment on local enterprise is likely to be understated by a dollar for dollar estimate of local investment foregone. The local entrepreneur as Levitt (1968) sees it is faced with the possibility of combining his resources with the TNE and becoming a salaried employee or contenting himself with a very limited role.

To the above economic concerns, Morse (1964) would add a political, legal and socio-cultural dimension to the areas for conflict between the TNE and the state. Traditionally, foreign investors have shown little respect for law or the legitimacy of power in their host countries, and even when they did, the basic differences of their expectations which are based upon presumptive rights have been a source of conflict. The problem is obviously compounded by the presence of three systems of law: one from the originating country, one from the host country, and the applicable body of international law that may exist. Sociological studies in areas of foreign investment are replete with examples of the conflicts that have emanated from the clash of the two cultures; the end results varying from complete domination to complete rejection (Persaud 1976). The TNE have certainly magnified the problems of extra territorality; tax loopholes and overlapping taxation in international economic relations.

One cannot overemphasize the fact that the above observations are generalizations at best and cannot be accepted as being present in all situations: Such a stance would automatically pose the major obstacle in making foreign investment contribute meaningfully, as it can, to the domestic economy. For instance, it is important in our deliberations on returned value that the repatriated profit and income stream be viewed over the period of the investment instead of isolated looks which may show what superficially appears as abnormal profits at a certain point in the production profile. Similarly, there is no substitute for a well defined national development policy which emphasizes in the broadest of terms the contribution that any foreign investment is required to make. The projects must be reviewed in the light of their consistency with the development objectives of the host country, including such factors as the growth and distribution of income, the expansion of employment, the impact on balance of payments and the absorption of new skills and technology.

Before discussing the options that are open to Guyana, a statement must be made on what social responsibility means in terms of a company's operations within the state, because a large part of the dissension between the state and the foreign investor arises out of the divergence in their respective views on this subject. The first premise to be accepted is that a socio-economic system which accepts the presence of a private sector must of necessity also accept the fact that the pivotal decision making concern is private survival whether defined as profit or otherwise. This, by definition, relegates to a lower order of priority other concerns which are external to the private survival motive. It is then clearly the responsibility of the state to set up the necessary institutional apparatus that guides the private decisions along social paths. Set in this mould, Morse (1964) views private enterprise as "socially aresponsible rather than irresponsible". Social responsibility whether on the part of a foreign or local investor will have to be set by society through its political institutions. This is indeed a crucial question even in systems where state control is prevalent, as evidenced in the conflicts that arose in Guyana's nationalized bauxite industry largely on account of the measure of social responsibility that is required of the company, and the vagueness of the distinction between the company's mandate as opposed to the responsibility of the local government authority.

OPTIONS OPEN TO THE STATE

The options open to the state are best viewed against the sources of frustrations for governments in mineral export economies. Briefly summarized, these frustrations as depicted in the preceeding sections are:

(i) Possible diseconomies associated with the non-procuctive use of large tracts of land.

(ii) High wages in mineral sector will foster higher wage demands in whatever local manufacturing that is present, thus decreasing the competitiveness of the latter.

(iii) Increased income especially to the small mineral-based elite is often translated into an increased demand for consumer durables which must be imported. This conspicuous consumption will probably exacerbate rural depopulation with a concomitant increase in the urban un- and under-employment.

(iv) The increasing demand for consumer durables will probably cause an increase in the inelasticity of demand for the products of the traditional agricultural sector, thus making more uncertain the potential magnitude of the income stream in this sector.

(v) The ability of the economy to meet basic deficiencies through imports, which are met by the increased income stream, may lull one into an ostrich-like sense of security with respect to the real possibilities of the economy for growth.

(vi) The income elasticity of demand for imports is very small for decreasing income, hence, in turbulent periods, these imports which fill the existing domestic dislocations will be a severe drag on the foreign exchange reserves.

(vii) Any decreases in the export sector cannot be met by similar cuts in public expenditure which is invariably promoting and maintaining essential services. The dependency of the economy on this export sector is therefore increased as the carrying costs of maintaining public infrastructure increases as the population increases.

(viii) Increased revenues can only come from increased taxation or public borrowing. Both of these may be made impossible due to corporate control, especially through the media of administered prices, intracorporate transfers, and fear of reprisal. Naturally, a bad credit rating can only get worse when the export sector suffers, hence public borrowing may be very difficult indeed.

(ix) The possible linkages that can emanate from the mineral activity are not available to the national economy because they have been appropriated within the vertically integrated transnational enterprise (Girvan, 1970).

The distinct choices that seem to be available to the underdeveloped state are either the adoption of some form of socialism or the creation of a mixed milieu in which private enterprise can function efficiently under the guidance of the state apparatus. In the latter alternative, the conflicts arising out of the distributive shortcomings of an unbridled free enterprise system can be circumvented, thus permitting the deploying of any privately generated surplus so that meaningful growth and development can occur.

The socialist alternative is extremely appealing since it offers a materials-balance approach, which will apparently bridge the gap between the disparities that exist between the structure of resource use and the structure of demand, as well as that between the structure of demand and the structure of the real material needs of the masses (Girvan, 1976). Based on the logic of this alternative, Girvan calls on the UDC for "a general disengagement from the international capitalist system" and a phasing out of the mineral exports to the centre countries, while concentrating on developing the necessary local expertise and technology either alone or in conjunction with other nation states in a similar predicament.

One must infer from Girvan's argument that the entire economy needs to be socialized, rather than any selective sector, resource or otherwise. This perhaps reflects an appreciation for the fact that the benefits of socialism, which is a general economic policy, can be achieved only if the greater part of the economy is in fact socialized. Second-best arguments may indicate that benefits may not necessarily arise, if, for example, the inputs or outputs of a socialized industry are in fact under monopoly control. However, unlike Girvan, Scott (1973) sees the socialization argument as one that cries out more for the socialization of the proceeds from resource exploitation, rather than socialization of the management Whether Scott's socialization process can be achieved in a system where the manager of the resource is nearly as powerful, if not more so that the state apparatus, is very questionable. In fact, in an underdeveloped state, socialization of management may be a necessary condition for the socialization of the proceeds attendant to the resource exploitation.

Girvan's prescription, though intuitively appealing, leaves a lot to be desired when the realities of the present international economic system, and more so the basic characteristics of the mineral industry are considered. Basically, the disengagement from the international capitalist system that he advocates must be accompanied by such massive internal reconstruction - both physical and mental - that it must of necessity clash headlong with the absorptive capacity of the UDC for such changes. This should not be interpreted to mean that internal structural changes which foster self-reliant development should not be undertaken. Rather, this dissertation argues a strong case for such changes. but with the provisio that "the revolution of rising expectations" of the peoples of the Third World cannot, and should not be expected to wait for the duration of the long gestation periods which radical changes will require before bearing fruit. To assume that the peoples of Guyana, the Caribbean, and Latin America will exercise the degree of forbearance that is required with an isolationist policy which does not immediately or in the medium term guarantee them even the meagre benefits to which they have been accustomed is veritably an exercise in wishful thinking. To even assume that the capitalist world which anyway has a greater capacity for absorbing such changes would stand idly by without countering such disengagement is truly naive at best. To even assume that among UDC there is a communality of interest which transcends the material aspirations of their individual communities to seize the opportunities they individually possess, is bordering on the ridiculous.

Enumeration of basic industries that are necessary for development in a mature economy is excellent from the standpoint of saying what has been achieved and what probably can be achieved given similar conditions. However, it does not necessarily follow that the presence of the required basic raw material inputs in underdeveloped countries will allow the establishment of those industries to the benefit of all, as every country regardless of the orientation of its trading partner will attempt to maximize the benefits which could be achieved from utilization of its physical endowment. Development must start with the given endowment of physical resources, and it must of necessity be augmented by external sources, especially when the constraints of small size inherently mitigate against complete self-reliance. The discussion on the implications of small size unambiguously demonstrates that failing regional integration efforts, contemporary small economies are doomed to a state of persistent poverty unless a base is established by which enough surplus is generated to facilitate a diversified development. These surpluses can probably more easily be achieved through the proper development of a natural resource sector, such as the mineral sector, whose ability to compete internationally is fortunately, relatively independent of the nation size.

Of course, the latter statement does not purport to deny the potential importance of agriculture and "grass root" development in surplus generation and in facilitating the diversification which is required. Rather, this thesis is in search of a solution to the obvious impasse and stagnation that currently characterizes the Guyanese economy. As seen in Chapter 2, agriculture's performance is dismal, the economic base of the country is far too narrow, and as will be developed in chapters 6 and 7, the possibility of mineral finds does exist. The thesis therefore puts forward the idea that more attention should be given to this natural endowment, as a partial measure to speed up the development process.

It is further argued that apart from the profits (if state run), or taxes royalties and unremitted profits (if privately run), and contribution to foreign exchange earnings, there are significant indirect benefits to be gotten from a properly functioning mineral sector. Though mineral activity is isolationist, and the attendant infrastructure has been very specific and outward oriented, one cannot lose sight of the fact that it is now conventional wisdom in the mining industry for the infrastructural development to complement its environment whether it is agricultural opportunities, or potential link industries. The realistic deployment of the infrastructure, coupled with the creation of technical skills and expertise can be of tremendous benefit . As McDivitt and Jeffery (1976) indicated, mining augments the three basic factors of production in the local economy by bringing dormant land resources into the mainstream, by augmenting local capital from external and internal sources, and upgrading local skills.

Foreign capital is normally investment specific and is not available for the rest of the economy, while local capital and foreign assistance funds must stand the test of the alternative claims in the economy. Considering that mining at the exploration stage is high-risk, and at the exploitation stage is capital intensive, it might definitely not be able to compete with those other lower-risk claims on limited funds. The inference clearly is that local capital should be used for shorter term, lower-risk, labour-intensive activity, while the foreign capital should be used for the higher-risk, longer-term mineral projects. Given the international nature of minerals, and its prominence in world trade, it is one of the few activities in developing countries that can successfully compete with the intermediate countries such as Canada and Australia for development capital. With the acceptance of the foreign investor, the state can ensure that at worst, it gains information on its resources, coupled with the initial exploration funds spent, while at best, it may be successful to see a whole new industry developed.

Emphasis will of course be made once more on the fact that mineral activity is simply a permissive condition - at best - to the achievement of the stated objectives of the state. The task of rational development rests clearly and squarely on the state apparatus and its institutions.

Public savings of the surplus from the industry must be undertaken to offset the capitalized value of the mine which will be exhausted at some time. Investment in the other forms of reproducible capital must be undertaken. Mikesell (1976) demonstrated a schedule of savings requirements from the income stream of a depleting mine in order that a self-maintaining annuity be created. For example, it shows that a country can double the capitalized value of a deposit of a 20-year life by the end of twenty years by saving 30% of the annual net returns given a 10% rate of discount. Similarly, a 30-year mineral deposit would require only a 6% saving to maintain the capitalized value. One must of course add that of this six percent, some portion must be set aside for continued exploration activity.

The list of basic industries that have historically been necessary for mature development as given by Thomas (1974) consists of iron and steel, aluminum, textiles, paper, plastics, rubber, glass, leather, cement, and industrial chemicals. Though these materials may be found collectively in the UDC, and perhaps indicate the future potential for cooperation among them, there is clearly no homogenity of interest in the group. Whatever common interest exists will certainly be stretched thin especially in the area of investment needs. Takeuchi et al (1977) demonstrated that the projected investment requirements for the UDC's nine most important non-fuel minerals (copper, lead, zinc, bauxite, alumina and aluminum, iron ore, phosphate rock, tin, nickel, and manganese) in 1976 to 1980 will be approximately $73 billion of which the UDC will be competing for approximately $38.5 billion. The corresponding figure for the 1981 to 1985 period that would allow the growth pattern of the respective minerals is $106 billion for the world, of which UDC will be competing for about $60 billion. The narrowness of the UDC known resource base is illustrated from the fact that 80% of these investments are required for copper, iron ore, and bauxite alone, while the addition of nickel brings the total to over 90%. It would, therefore, appear that failing the required homogenity for effective action, the individual state would have to plan its development, as if cooperation would only be obtained at a high social, political and economic price.

Appendix (13) is offered to illustrate the magnitude of the capital requirements for mineral based activity. From the standpoint of the small nation state, it is clearly evident that an attempt at developing the iron and aluminum industries which are on Thomas' basic list can indeed be a monumental task. It is also to be noted that some of these figures do not cover infrastructural costs which historically amount to about 60% of project cost. Increased indebtedness and low credit ratings added to these large financial requirements have made it virtually impossible for a small state to completely develop a new mineral sector on its own; hence the need for external assistance. Though it is a distressing thought, it must be admitted that any new mineral sector development in any small UDC - Guyana included - must contemplate a role for the foreign investor! The question then resorts to the definition of a path which is mutually acceptable to both parties; while the state tackles the monumental task of reconstruction.

In the unlikely event that the capital resources are available to the state, it is pertinent for the enquiry to address itself to the mechanism of technology transfer which does not bring with it the control that is inherent in the foreign equity capital. The likely alternatives that have been bandied about are purchasing of equipment, licences, consultancies, and industrial cooperation agreements as between market and socialist economies. These are not without their drawbacks as the cooperation agreements require a high technical absorptive capacity which in all probability is lacking in UDC's, while companies have a preference for safeguarding licences within their corporate umbrella. It is even possible that low cost licences may turn out to be extremely costly in view of the UDC's inability to clearly distinguish between different technological packages of licences plus equipment plus service. Fourthly, even though technology could be divorced from capital, it is highly unlikely that it can be divorced from the management required to run it, and there is certainly a paucity of good footloose management.

A growing fascination is developing in the underdeveloped world for joint ventures between foreign capital and local interests. The principal benefits of this arrangement for the country is that it could exercise greater sovereignty over the disposition of the resource while hopefully increasing its take. To the company, joint ventures are a means of reducing risk, ensuring necessary supplies, while their lower capital commitments allow them to deploy resources elsewhere.

In recent times, joint ventures have been subject to severe scrutiny as their true benefits have been alleged to be more imagined than real. Examination of these deals as depicted by Girvan (1974) reveals that invariably the changes have emphasized more form than content. In the Chilean and Zambian joint ventures, the foreign companies did not only increase their return through government concessions on taxes, profit remittances, asset valuation and government-financed expansion programmes, but they also maintained effective control over the running of the enterprise through management contracts, and minority shareholders rights. It was precisely the above concerns which led the Guyana government to establish a set of non-negotiable conditions when talks on partnership in the Guyanese bauxite industry were initiated; which talks eventually led to the complete nationalization of the industry (Burnham 1970, 1971).

Without doubt, several states have embarked on mineral ventures alone or in partnership with others at terms that are advantageous to them. Iran, Mexico, and

Phillipines are fine examples, while the Papua New Guinea government renegotiated advantageous arrangements for its Bougainville deposit (Zorn, 1977). However, if the recently concluded arrangements between Papua New Guinea and the Panamian governments with foreign investors on their Ok Tedi and Cerro Colorado deposits respectively are representative, some significant changes are to be noted in government-company relations. The most significant trend is that there has been a strengthening of the position of the companies in dealing with host governments, as the conditions of the agreement are far from concessionary to the host governments.

The Ok Tedi deposit is slated to cost approximately U.S. $800 million, while the Cerro Colorado deposit will involve nearly U.S. $1 billion. These large capital requirements have resulted in a greater presence of the banks and other financing houses in the deal, since the companies could not generate these funds internally. Because of the great indebtedness of the underdeveloped countries which increased from $50 billion to $180 billion in 1976, these banks are typically insisting on quick recoupment, and strict adherence to loan commitments (Zorn, 1977). In both agreements. expressions of sovereignty were formally recognized, yet not practically expressed as dispute settlement arrangements have not adhered to the Latin American-style Calvo doctrine where final jurisdictional rights rest with the state, but rather, allowance is made for third parties. The contracts have stipulations of staged development where either party could rethink its position after certain periods, while the major decision-making role in the jointly owned company was to rest with the foreign investor regardless of its minority position. Another significant provision was for the increase of the government's take in the latter years of the project, along with phase out provisions for complete transfer to government in the latter years.

The severity of the terms of the concessions from the government's standpoint would seemingly negate the argument for foreign involvement. However, it must be stressed that these contracts were concluded at a specific time in the development of the copper industry when the copper market was plagued with depressed prices and surplus stocks. Secondly, the specific metal under investigation would have an important bearing on the negotiating position of either parties. The more strategic the mineral, the greater the bargaining potential of the government. Certainly, copper does not fulfill this criterion whether defined as an irreplaceable input to industrial activity, or whether as conferring significant market-cornering potential to the vertically integrated company. One need only look at the uranium contracts to realize the over-riding presence of government in the alienation of this mineral. Thirdly, the socio-political environment and the infrastructural base will be key determinants in the final negotiating position of either side, and it will invariably make the difference between a feasible venture or an undeveloped resource.

The principal intrastructural base is geological knowledge, and a country's bargaining ability varies directly with it. Because exploration is a high-risk activity, it is expected that companies would place a high premium on obtaining the lion's share of any mineral find, if they are required to undertake the initial exploration work. This would seemingly indicate that the responsibility of initial exploration would rest on the government except it views the benefits to be achieved by a better bargaining position, through greater delineation of its resource position, is less than the cost of obtaining that information. The government can undertake to carry out the exploration itself either through one of its departments, or by a relatively independent parastatal organization such as Mindeco in Zambia or Soquem in Quebec. However, such approaches require a large personal commitment of funds which to all intents are lacking, while the expertise may be non-existent. To offset the question of the expertise, Bosson and Varion (1977) describe the arrangements in Peru, Bolivia, Iran and Indonesia where the required exploration is contracted out to large multinationals, in return for a fee or a part of a return of any successful venture as the government sees fit.

The above, however, does not solve the problem of the paucity of funds. Apart from the mining companies, financial institutions, consumers and trading companies, suppliers credits, and speculators which anyway favour more developed markets, there are only a few sources of finance for exploration in underdeveloped countries. The principal ones are the UN Development Programme (UNDP) and the recently created UN Natural Resources Exploration Fund (UN, 1975). This latter fund is extremely significant because of its grant element in cases where exploration activity is unsuccessful. In cases of successful exploration, the replenishment contribution of the project to the fund is approximately 2% of the gross earnings from the commencement of production to about 15 years hence or until a specified ceiling is reached. The resources of this fund are presently quite small, but it may become of tremendous significance as it develops.

All parties are fully aware that stability in contract terms is a prerequisite for smooth relations. However, stability does not mean rigidity, and mining contracts must be flexible to accommodate changing situations of a permanent nature, since injury to either party caused by the changed situation will only lead to greater tension with long-term explosive potential. Waelde (1977) astutely refers to contracts as a stage in a highly formalized bargaining process, in which the contractual terms are terms of reference for future renegotiations. From the government's standpoint, entry into contracts should begin with its investment laws, and mining codes which are its terms of reference. Bargaining can be initiated from a strong mining code and concessions sold, or it can be initiated from a minimally defined set of standards with room for bargaining on the project details.

The state needs information on the contribution the investment is expected to make to production, employment, exports, import saving, government revenues, balance of payments, local industry and to general development overtime. It should also be thoroughly cognizant of the accounting practices of the firm and the implications specific provisions may have on its balance sheet, instead of the firm interpreting the latter for it. Provisions such as taxes, profit repatriation, tariffs, local borrowing, etc., are essential to the firm and should be well analyzed by government so that the final return to itself and the company can be easily ascertained, and that any contract would emphasize content over form.

The required expression of content over form can take its meaning from the state realizing that it is acting as a seller of mineral rights which the company wants to buy. It is therefore incumbent on the state to establish a base return on investment which it is prepared to guarantee the foreign investor, should a viable deposit be found. Once this is realized, the state can effectively appropriate the giant's share, without fear of the investment being relocated. Currently, it is thought that a return of investment of 15% to 18% is adequate to induce the foreign investor, given the possibility of a stable environment (Mikesell,1976). The moves by provincial governments such as Quebec, Ontario, and Manitoba to define their tax structures along lines that isolate excess profits are all indicators of the attempt to first guarantee the investor a reasonable return to his investment, and then the state appropriating the lion's share of the resource rent. As will be shown in Chapter 9, it may be possible theoretically to appropriate all the excess, but psychic income effects would require that some part of the excess is retained by the investor so that reinvestment and internal efficiency are not affected.

Of course, the government should not invite the investor if the project cannot create enough return for both of them. Guaranteeing the investor his share presupposes that the state is also satisfied with the return the package will yield to itself. The state will have to calculate the present value of the benefits (dividends to itself, taxes, royalties, witholding taxes, etc.) and of the costs (infrastructural costs such as roads, communication, etc.) that will be consequent to the project implementation. Once it is satisfied with the totality of the package, then it can tackle the form of the agreement in terms of how revenues will be collected, what will be compromises of sovereignty, what mechanisms will be used to control the enterprise in pricing and allocative terms, and what dispute settling mechanisms may be desired. It would be extremely ill-advised to enter into an agreement which is burdened with preoccupations of realizing objectives in a development plan, as this can often times lead to concessionary legislation since the importance of the project to the state then looms much larger, and the foreign investor then possesses all the trumps. One need not reiterate the explosive potential of any agreement that initially confers excessive advantages to the investor, especially as the project matures in a restive political environment.

CHAPTER SIX

GEOLOGICAL SETTING

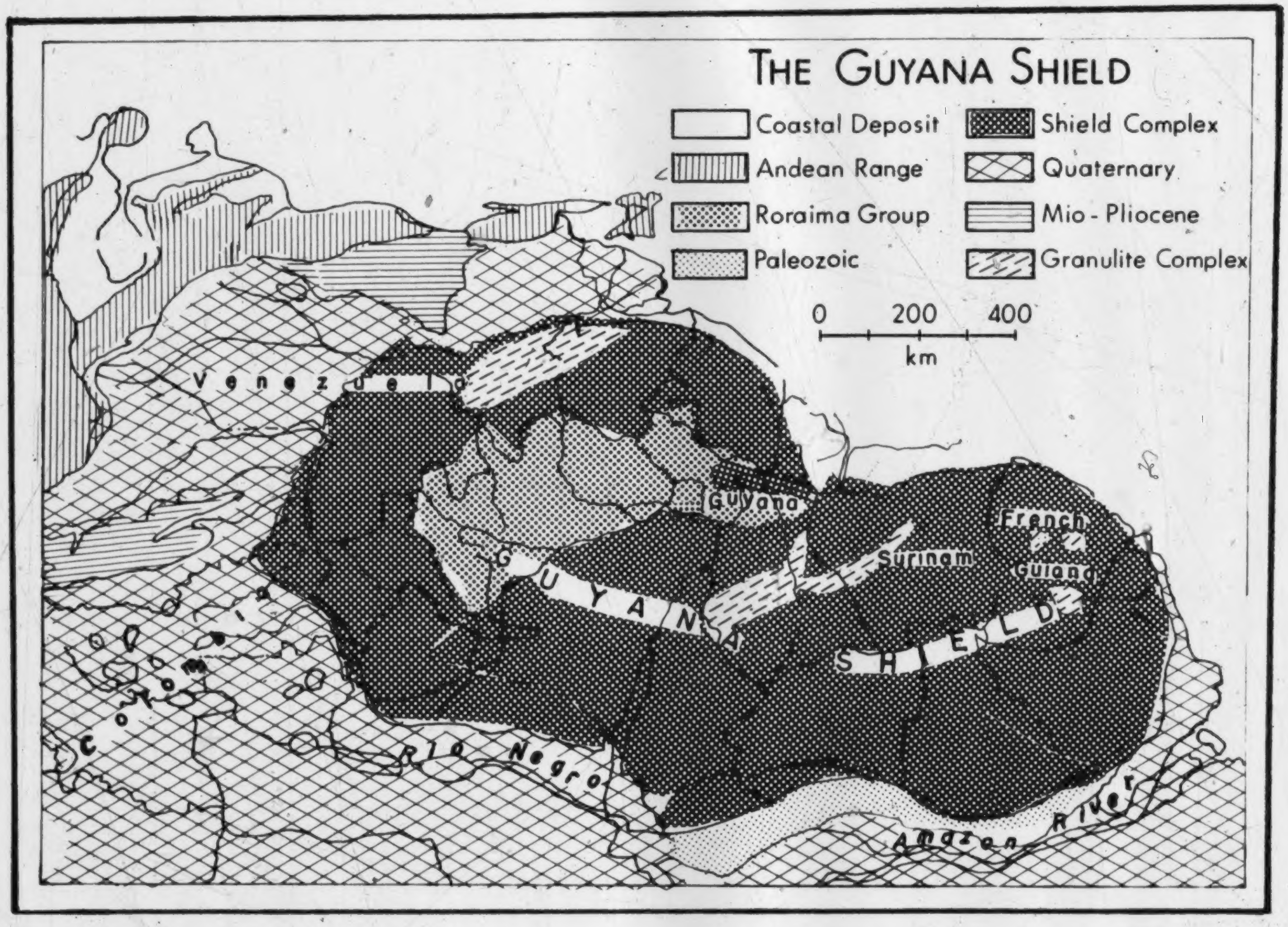
Traditionally, discussions on the geological setting of Guyana emphasize the observation that there is a tectonic break at approximately 4^{O}N latitude, which divides the country into a northern and a southern geological province. (McConnell et al 1964, Williams et al 1967). This break represents a difference in structural style, stratigraphy and lithology from a greenstone "eugeosynclinal" sequence in the north to a high grade group of metamorphic rocks in the south (Williams et al 1967, Barron 1969).

Unfortunately, this break also represents the limits of historical geological activity which quite disproportionately has been restricted almost exclusively to the northern province. Understandably, the attractiveness of greenstone terrains as metallogenic entities coupled with the comparative ease of accessibility of the northern areas have been the dominant reasons for this emphasis. However, the relative lack of success of the exploration effort in the northern province (see Chapter 7), and the need to inventorize the mineral potential of the entire country would demand a thorough re-evaluation based upon newer scientific concepts.

This dissertation endeavours to remove the psychological barrier of the tectonic break, while seeking to represent the geology of Guyana as an integrated whole. It sets out to establish that the traditionally different northern and southern provinces represent segments of earth history that are linked in an intimate fashion not only to themselves but also to the rest of the Guyana Shield (Fig. 6) of which they are a part, and to a larger Precambrian lithosphere, which included the continent of Africa. This approach will hopefully facilitate the easy recognition of those environments which are most likely to contain mineralization.

The recent plethora of radiometric ages, which have become available, makes it possible for the stratigraphy of Guyana to be outlined in a definitive way (see Table 26). The discussion in this chapter will start with the basement sequence and it will then account for successively higher levels in the stratigraphy. It must be observed that reference is made to a "basinal" sequence instead of a "geosync linal" sequence which has been traditionally the common practice. The first intent is to avoid entering the controversy which surrounds the "geosynclinal" term especially with respect to its genetic implications. Secondly, in the specific case of the Guyana shield, and for parts of the West African Craton, to which this thesis will refer, it is thought that the simple descriptive term "basin" best represents the areas presently occupied by supracrustals of variable low metamorphic grade, and separated from each other by high grade metamorphic areas. The discussion proceeds from basinal sequences and their related shelf sequences to cratonic sequences. Account is then taken of

FIGURE 6


THE GUYANA SHIELD
Coastal Deposit
Andean Range
Roraima Group
Paleozoic
Shield Complex
Quaternary
Mio - Pliocene
Granulite Complex
0
200
400
km
Venezuela
Colombia
Rio Negro
Guyana
Surinam
French Guiana
GUYANA SHIELD
Amazon River

Modified after McConnell (1969)

Table 26

Lithostratigraphic and Tectonic Evolution of Guyana

EPISODE	AGE (APPARENT) Ma	GEOLOGICAL PROCESS	LITHOSTRATIGRAPHIC UNIT AND COMMENTS		
	PHANEROZOIC				
	Holocene	Sedimentation	RIVERS FORMATION	CORENTYNE GROUP	Riverine alluvium
	Pleistocene-Oligocene	Estuarine and fluviatile sedimentation	NORTH SAVANNA FORMATION BERBICE FORMATION		Estuarine and fluviatile alluvium
	Oligocene-Eocene	Lateritisation	HAPPI LATERITE FORMATION		Laterite and red earth
TAKUTU EPISODE	Lower Cretaceous-Jurassic	Paralic sedimentation in rift valley Extrusion of THOLEIITE LAVAS	TAKUTU FORMATION APOTERI VOLCANIC FORMATION	REWA GROUP	Sediments Basalt flows
		RIFT VALLEY FAULTING			
	Permo-Triassic Ordovician	Intrusion of THOLEIITE DYKES Intrusion of THOLEIITE DYKES	BASIC DYKE SUITE		Dolerite Dykes
	PROTEROZOIC				
K'MUDKU or NICKERIE EPISODE	1200 ± 100 Ma	Intense shearing, mylonitisation and fusion of brittle rocks			Mylonite and pseudotachylite
RORAIMA EPISODE	>1536 ± 50	Intrusion of THOLEIITE SHEET	RORAIMA DOLERITES		
		Block Faulting - Uplift Erosion	Juxtaposition of high and low grade metamorphics in the Kanuku(?) Juxtaposition of root zone Bartica Assemblage to lower Metamorphic grade Barama-Mazaruni Supergroup		
Trans Amazonian Tectono-thermal event: Surinam Episode	1814 ± 64	Sub-volcanic granophyres and acid-intermediate volcanics	Burro-Burro Group	Cratonic environment	
	1805 ± 40	Shallow water sedimentation uplift Folding, metamorphism and granite reactivation NW-SE trends dominant	Kuyuwini Group Younger Granites South Savanna Granite Essequibo-Corentyne Granite Bartica Assemblage Appinitic Intrusive Suite	Mainly allochtonous K granite	
	1922 ± 42	Intrusion of Norite Plutons			
		Hiatus in Plutonism	Haimaraka pelites - Muruwa arenites UPPER KWITARO		
Trans Amazonian Tectono-thermal event: Guyana Episode	2270 ± 185 2375 ± 25 2392 ± 47	Folding, metamorphism and granite emplacement NE-SW trends dominant	Younger Granite South Savanna Granite Reworking of Kanuku Group of granulites and migmatites	Mainly gray autochthonous Na granitoids	
		Extrusion of basalts and Intrusion of basic dykes	Barama-Mazaruni Supergroup		
		Uplift, Erosion Cratogenic conditions	Kwitaro Group		
Imataca* Episode	2720	Supamo-Kanuku Basement reactivation			
		Hiatus in plutonism; Sedimentation			
Gurian* Episode	3100-3400	Reactivation of Protoshield			

* Inferred from Imataca province in Venezuela.

Modified after Berrangé (1977) to reflect both northern and southern Guyana.

the graben sequences, metamorphism and granitisation, mafic and ultramafic intrusives, and finally concludes with a note on the global setting and tectonics of Guyana in a Gondwanaland context.

HIGH GRADE METAMORPHICS: THE KANUKU COMPLEX

The Guyana shield which occupies the north-eastern region of South America, is traversed by three known areas of high-grade metamorphic rocks (Fig. 6). In the north-western portion of the shield, there is the Imataca complex in Venezuela, and in the central portion is the Kanuku complex of Guyana which continues into Surinam, where it forms the Coeroni - Adampada - Falawatra high grade metamorphics, the latter forming the Bakhuis mountains. In French Guiana, these high grade metamorphics are represented by the Isle de Cayenne Group, which is not as extensive as the other two zones in Venezuela, and Guyana-Surinam (Kalliokoski 1965, McConnell et al 1964. Priem 1969, Choubert 1974, Spooner et al 1971, Berrange 1977). The Imataca complex separates a north-western Real Corona - El Torno basin from a south-eastern Venezuela - Guyana basin, while the Kanuku Complex separates the latter from a south-easterly Surinam-French Guiana basin.

The Kanuku Complex is an arcuate, easterly-trending belt (40 to 104 km wide) of granulites and migmatites which underlies approximately one-tenth of the area of Guyana, between Brazil to the west and Surinam to the east. It is bounded on the north by the Takatu Rift Valley; to the north-east by the Essequibo-Corentyne Granite Complex and to the south by the Southern Guyana Granite Complex, with which it displays pervasive intrusive relationships. The migmatites and granulites were once thought to be synkinematic (Singh 1966), but were more recently shown by Berrange (1977) to represent two distinct phases of crustal history with the granulites representing remnants of an older basement, while the migmatites represent the supracrustals derived from this basement, which now assumes a xenolithic relationship to the migmatites (see Fig. 7 in enclosure).

Berrange (1977) recognizes five types of gneisses in the Kanuku Migmatites which are essentially veined, streaky and nebulitic, with minor banded types. These five types are:

(i) Biotite ± (Cordierite, sillimanite, garnet, hypersthene) paragneisses and migmatites.
(ii) Graphitic paragneisses
(iii) Quartzites and banded ironstones
(iv) Calc-silicate paragneisses
(v) Basic granulites, pyribolites and amphibolites.

Of these, the biotite - garnet - sillimanite gneisses are the most abundant, and Singh (1966) divides them into hypersthene and non-hypersthene types, while Berrange (1977) establishes three kinds based on the presence or absence of garnet, sillimanite, cordierite, and hypersthene. It is to be noted that the east-south east trending fault at

Schomburgk Falls separates a northern region of biotite - garnet - sillimanite paragneisses from a southern lower grade biotite - cordierite paragneiss. Similarly, the north-south trending faulted surface between Rewa River and Coco Creek, also separates biotite - hypersthene paragneisses to the west and the biotite - garnet - sillimanite to the east (Berrange 1977). The latter author insists that contrary to Singh's (1966) thesis, which postulated that the biotite - hypersthene gneisses are primarily products of contamination by relict basic granulites and boudins, that the biotite - hypersthene gneisses constitute paragneisses in their own right, being formed as a result of prograde regional metamorphism. The impression is also clearly gained that the juxtaposition of rocks of different grades on either side of faulted surfaces may be a result of vertical tectonics which has upthrown higher-grade, deepseated rocks such as those in the north-west of the complex and set them against lower-grade, higher-level rocks in the east and south-east.

The biotite - garnet - sillimanite paragneisses are highly quartzo-feldspathic (Quartz: 20 to 40%; K-Fspr 30 - 60%; plagioclase 5%) and carry about 10 to 20% biolite. The quartz is strained and xenoblastic while potash feldspar is essentially microcline. The amount of garnet and cordierite are variable, while sillimanite is typically seen to follow them, to the extent where they are completely replaced in the north eastern sector of the complex by sillimanite-bearing rocks. The quartzo-feldspathic component occurring as distinct veins and pegmatites is characteristically highest near the granite contact to the south and north-east and very minimal in the granulitic, high-grade areas in the west of the complex.

Minor amounts of graphitic paragneiss are found between Manarowa Falls and Paumbo Island on the Essequibo River and like the small amounts of calc-silicate paragneisses at the confluence of the Coco Creek with the Essequibo, they are interbedded in the biotite-garnet-sillimanite gneisses. These calc-silicates were probably derived from calcareous shales, which were poor in carbonates as no marbles were found except for a small occurrence between Jacob's Ladder Falls and Schomburg Falls on the Essequibo and east of it in the New River area. The calc-silicates and graphitic paragneisses are intimately associated with the basic granulites, pyribolites, and amphibolites which are both ortho- and para-gneisses (Berrange 1977). Numerous small occurrences of quartzite, and banded ironstone have been reported by Barron (1962), Singh (1966), and Berrange (1977). These are essentially metasedimentary sequences with all gradations in iron and silica content that occur interbedded with the biotite paragneisses at Wichabai, Tiger Hill, and on the New and Oronoque rivers.

THE KANUKU GRANULITES

The Kanuku Granulites are spatially restricted to the Kanuku Mountains (west of Rewa River) and to an eastern area north of Coco Creek. They are typically differentiated into acid granulites with a fine-grained foliated granulitic fabric, and enderbites with a medium grained granitic fabric with rare mangerite and charnockites. The granulites and enderbites east of the Rewa River (i.e. those in the north-east of complex; north of Coco Creek) are typically hornblende-augite k-feldspar types with little or no biotite or hypersthene, while those in the west (the Kanuku Mountains and South Savannas) are typically biotite-hypersthene-plagioclase or biotite acid granulites. As mentioned in the case of the biotite migmatites, the impression is clearly gained that a section from east to west reveals increasing metamorphic grade, with a rapid transition across the faults referred to in the earlier section. From east to west, enderbites and granulites show a change from microcline, hornblende, augite, brown biotite, and a paucity of basic granulites and pyribolites to the west where orthoclase, abundant reddish brown biotite, orthopyroxene and abundant basic granulites and pyribolites occur. Singh (1966) also described alaskitic granulites which compare with Berrange's Wamukaru granulites in the Kanuku Mountains. They have variable amounts of garnet and are similar to the alaskites associated with the Makarapan riebeckite granite found on the Makarapan Mountains on the northern side of the rift valley, and are possible correlatives of the Kanuku Complex (Berrange 1970, 1977).

Numerous pegmatites and aplites are found in the Kanuku Complex, especially at the marginal contacts with the

South Savanna Granite and the Essequibo Corentyne Granite, where they increase in thickness, occurrence, and quartzo-feldspathic component. The pegmatites are for the most part divided into an earlier deformed group which are principally non-dilational and of a replacement origin, and a relatively undeformed, discordant group which has dilational features and is younger than the enclosing rock. It is significant that these later pegmatites are characteristically tourmaline-bearing and show signs of a high volatile content (Singh 1966). The earlier pegmatites are characterized by a multitude of pinch and swell structures which are rimmed by dark biotite-sillimanite differentiates and which have foliation conformable with the shape of the pegmatite.

The acid and basic (noritic) granulites, which are competent with respect to the incompetent biotite gneisses, have been deformed plasticly to form ptygmatic folds, pinch and swell structures and various sizes (inches to feet) of boudins, which in turn are tightly folded with fold axes parallel to the foliation (Singh 1966, Berrange 1977, Barron 1962). On the south and north-east, contacts with the batholithic granites of the South Savanna and Essequibo-Corentyne Granite complexes, the Kanuku migmatites pass into the transitional Kusad Augen gneiss and the Corentyne Granite Gneiss repectively. These are essentially middle to upper amphibolite grade rocks with a high quartzo-feldspathic content, augen, biotite and muscovite (Barron 1962).

In contrast to the generally lower grade of metamorphism of these transitional gneisses, the Kanuku Migmatites in the western sector have achieved the hornblende - orthopyroxene - plagioclase granulite facies of low-pressure, steep-geothermal Abukuma-type of metamorphism. However, the rocks to the east which are devoid of orthopyroxene, and sparse orthoclase, have only reached the sillimanite - orthoclase - cordierite - almandine amphibolite subfacies of metamorphism (Berrange 1977).

The granulites are very H_2O-poor compared to the migmatites, and this would probably account for the paucity of quartzo-feldspathic veins and dykes in the higher grade terrain. Singh (1966) attributes their high metamorphic grade and "dryness" to compaction in the nose of folds, as in the case of the Darukoban-Kudiditau Massif which he interprets as a tight anticlinal structure, in the nose of which the high grade granulite rocks were produced. He contends that the migmatites are gradational in every respect to the granulites in terms of their bulk composition, and hence must have the same parentage. Any observed differences in mineralogy are a reflection of the grade of metamorphism, and of the availability of water. He uses as arguments the observations that orthopyroxene replaces clinopyroxene, orthoclase replaces microcline, and sillimanite replaces cordierite and garnets when a transition is made from migmatites to the granulites. In contrast, Berrange (1970, 1977) argues that the granulites represent segments of an older basement, while the "wetter" supracrustals that form the migmatites represent the erosion products of this older basement. In this connection, Berrange (1977) tenders structural data to show that the Darukoban-Kudiditau Massif is a domal feature, rather than an anticlinal one; the latter being of course crucial to Singh's high-grading event.

It is immediately obvious that any attempt to answer the question of the relationship between the migmatites and the granulites must first explain the antecedence of the groups of rocks. Singh (1966) used chemical data in an AFM diagram, and in variation diagrams to conclude that the migmatites and granulites have an igneous parentage with calc-alkali differentiation trends. It must be said that Singh's conclusions hinged largely on the apparent similarities between his rocks and those of the charnockites and associated rocks with calc-alkali trends found in Madras and Uganda. Analyses of his rocks, some from the Imataca complex, and some reference suites are reproduced in Table 27 for comparison. In Singh's scheme, the Biotite Gneisses were derived from granitic rocks, which responded to metamorphism by mineral segregation, while subsequent granitization and migmatization accentuated or superimposed other bands. The basic granulites and gneisses are simply metabasic dolerites and gabbros which were intruded into the granitoid rocks, with which they were metamorphosed. Locally in the cores of tight folds, granulites developed.

segments of an older basement, while the "wetter" supracrustals that form the migmatites represent the erosion products of this older basement. In this connection, Berrange (1977) tenders structural data to show that the Darukoban-Kudiditau Massif is a domal feature, rather than an anticlinal one; the latter being of course crucial to Singh's high-grading event.

It is immediately obvious that any attempt to answer the question of the relationship between the migmatites and the granulites must first explain the antecedence of the groups of rocks. Singh (1966) used chemical data in an AFM diagram, and in variation diagrams to conclude that the migmatites and granulites have an igneous parentage with calc-alkali differentiation trends. It must be said that Singh's conclusions hinged largely on the apparent similarities between his rocks and those of the charnockites and associated rocks with calc-alkali trends found in Madras and Uganda. Analyses of his rocks, some from the Imataca complex, and some reference suites are reproduced in Table 27 for comparison. In Singh's scheme, the Biotite Gneisses were derived from granitic rocks, which responded to metamorphism by mineral segregation, while subsequent granitization and migmatization accentuated or superimposed other bands. The basic granulites and gneisses are simply metabasic dolerites and gabbros which were intruded into the granitoid rocks, with which they were metomophosed. Locally in the cores of tight folds, granulites developed.

Table 27

Chemical Analyses of Rocks From the Kanuku Complex, the Imataca Complex, the Cerro la Ceiba Migmatites Compared with Average Greywacke, Shale, and Ocean Tholeiites

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S_1O_2	69.52	67.93	72.6	71.21	67.43	70.80	51.64	51.29	67.20	62.07	49.9	64.7	68.1	74.43	58.10
Al_2O_3	14.19	13.95	13.54	14.95	14.58	14.44	15.52	16.50	15.92	13.73	17.2	14.8	15.4	11.32	15.40
TiO_2	.63	0.49	.59	0.11	.60	0.21	.71	1.03	.42	0.62	1.51	0.5	0.7	0.83	0.65
Fe_2O_3	2.14	0,48	1.67	0.32	1.52	0.16	2.48	0.82	2.71	6.12	9.7	1.5	3.4	0.81	4.02
FeO	2.22	4.85	1.84	0.08	3.15	1.26	8.72	7.74	---	---	---	3.9	3.4	3.88	2.45
MgO	1.45	1.77	1.10	0.25	1.33	0.24	7.64	5.21	.86	2.84	7.2	2.2	1.8	1.30	2.44
MnO	.03	---	.04	---	.06	---	.20	---	.05	0.08	0.17	0.1	0.2	0.04	---
CaO	2.34	2.48	1.56	1.34	2.66	0.93	11.26	6.43	2.93	5.04	11.8	3.1	2.3	1.17	3.11
Na_2O	3.29	3.00	2.86	4.75	2.90	3.98	1.20	3.76	4.20	7.65	2.7	3.1	2.6	1.63	1.30
K_2O	3.62	1.62	4.53	4.51	5.06	5.65	.29	1.79	1.43	0.99	0.16	1.9	2.2	1.74	3.24
H_2O^+	.34	---	.11	---	.27	---	.04	---	---	---	---	2.4	2.1	2.15	5.00
H_2O^-	.11	---	.09	---	.08	---	.09	---	---	---	---	0.7	---	0.20	
P_2O_5	.10	---	.04	---	.38	---	.11	---	---	---	---	0.2	0.2	0.18	0.17
Fusion Loss	---	3.50	---	1.78	---	2.43	---	3.00	4.39	4.60	---	---	---	---	---

Columns 1, 3, 5 and 7 are from the Kamku Complex (Singh 1966).
Columns 2, 4, 6 and 8 are from the Imataca Complex (Dougan 1977).
Columns 9, 10 are from the Cerro La Ceiba migmatite gneisses (Dougan 1976).
Column 11 is an average of ten oceanic tholeiites (Engel et al. 1965).
Columns 12 to 15 are averages of greywacke (12-14) and shales (15) (Pettijohn 1957).
Columns 1 and 2 are described as Biotote-gneisses.
Columns 3 and 4 are described as felsic granulites.
Columns 5 and 6 are described as non-migmatitic granitic gneisses.
Columns 7 and 8 are described as mafic granulites.

Table 27 shows that the bulk chemistry of the Kanuku rocks bears a striking resemblance to an antecedence of greywacke and shale, and have been very instrumental in Berrange (1977) favouring a supracrustal origin for the migmatites. He contends that the regular compositional bands and fine stripes coupled with the interlayering of obvious metasediments (the calc-silicates, quartzites, graphitic gneisses) would indicate a supracrustal origin. The common association of sillimanite, cordierite and garnet in the gneisses is truly representative of a metasedimentary origin, while the ubiquitous rounded zircons identified by Singh (1966) are more representative of products of attrition due to erosion, hence of sedimentary origin. Similarly, the pyribolites and concordant amphibolites are considered to represent stratiform volcanics. This scheme of things which purports to represent the facts would then indicate that the migmatites were developed in-situ by anatexis, with the banding and gneissic layering being relics of a former supracrustal layering which was emphasized by metamorphic differentiation.

Included in Table 27 are aggregated analyses of rocks from the neighbouring Imatacan Complex in Venezuela. One should first observe that columns 2, 4, 6, and 8 are representative of granulitic and high grade biotite and charnockitic gneisses from the Imatacan Complex proper (i.e. north of the Guri-Cuidad Piar Fault Zone). Columns 9 and 10 represent aggregated analyses of essentially high grade biotite - quartz - oligoclase gneisses found south of the Guri-Piar Fault Zone. It is interesting to observe that this area south of the fault is occupied by rocks which in every way, compositionally and otherwise, resemble the biotite gneisses of the Imataca Complex to the north, even with respect to the presence of iron formations - albiet of a lower tenor, and metamorphism though of a lower grade (Dougan 1976). This biotite quartz-oligoclase gneiss with interbedded iron formations also passes laterally via a faulted contact to the west to the Cerro la Ceiba Quartz Monzonite Migmatite Complex, which is relatively free of iron formations, and which is thought to overlie the Imataca iron-bearing segments (Kalliokoski 1965).

The similarity in composition between the Guyana Kanuku Migmatites and that of the Cerro la Ceiba Migmatite Complex in Venezuela lends credence to the view that the Supamo Complex, which is thought to be represented by the Cerro La Ceiba Complex, is probably the basement of the Venezuela - Guyana, Late Archean - Early Proterozoic basinal sequences (Hurley et al 1976). The Supamo Complex is thought to be an admixture of injection gneisses, migmatites, and granitic rocks containing an older fine-grained, gray, hornblende - biotite - quartz - feldspar gneiss which is penetrated by later Trans-Amazonian, coarse-medium grained pink granitic phases including pegmatites.

From a stratigraphic standpoint, the Imataca Complex found north of the Guri-Piar fault is probably the lowest member of the rocks described. Next in succession is the group of iron-formation bearing rocks of slightly lower grade ~~gneisses,~~ found to the south of the fault zone. These rocks are then probably overlain by the almandine-amphibolite grade, gneissic rocks, which lie in faulted contact west of the high-grade charnockitic granulites of the Eastern Imataca Complex. It is in these almandine-amphibolite grade rocks that the Cerro la Ceiba migmatites are located. Radiometric dating of rocks in the Cerro la Ceiba area typically show a cluster of ages around 2720 Ma, while the metasediments and meta igneous rocks of the Eastern Imataca Complex gives a scatter of ages between 3100 Ma and 3400 Ma, reflecting an earlier orogeny (Hurley et al 1976). Gaudette et al (1978) have reported a Rb/Sr age of 2817 ± 57 Ma for the Supamo Complex in Venezuela and the Bakhuis Mountains in Surinam when a Rb87/Sr86 ratio of less than 0.4 is used. Higher initial ratios, are typically associated with the younger ages approaching 2100 Ma, reflecting perhaps the introduction of alkalis during the later Trans-Amazonian event. The U/Pb plot on zircons gave an age of 2660 ± 30 Ma.

It is therefore hereby concluded that the Cerro la Ceiba migmatites and their earlier or contemporaneous correlatives, which bear iron-formations to the east, represent the present granulite grade rocks which are found in the Kanuku Complex of Guyana and which were produced during the later Trans-Amazonian tectono-thermal event dated at 2000 ± 200 Ma in Guyana, and Venezuela as has been shown by the Encruijada granite which intrudes the migmatites and is dated at 2110 ± 87 Ma (Posadas et al. 1967).

The latter discussion would seemingly infer that a search for compositional correlatives of the Kanuku Complex should therefore be focused upon the stratigraphically higher migmatites and biotite gneisses found to the west and south of the charnockitic rocks of the eastern Imataca Complex. As such, Berrange's comparison of the Kanuku with the Imataca based on the observed stratification, low lime content, rounded zircons, quartzitic horizons, and iron formations necessarily prejudge and bias the discussion, since the rocks compared are definitely of different ages (The Imatacan supracrustals are approximately 3100 - 3400 Ma old, while the Kanuku Complex typically give a range of ages from 2800 to 2000 Ma. (Hurley et al, 1976).

Dougan (1976) first thought that the quartz-oligoclase biotite gneisses to the south of Cuidad-Piar fault were of an igneous tholeiitic parentage, though the highly oxidized nature of the rocks as given by the high Fe_2O_3 content would mitigate strongly against an igneous parentage. It is to be noted that oceanic tholeiites characteristically have a Fe_2O_3/FeO ratios of 0.15 (Engel et al 1965), while the corresponding ratios for Dougan's rocks and the Kanuku migmatites and granulites are close to unity. Secondly most of his major and minor element plots show an overlapping igneous-sedimentary parentage, while a mechanism of partial melting of greywackes at low pressure and about 700°C - 750°C (Abukuma type conditions) in the presence of chloride solutions (Kilnic 1972) can very well account for an origin of such rocks. It is noteworthy that Dougan (1976) does not discount this possibility and in his later assessment of the biotite gneisses (Dougan 1977), he concluded that they are "clearly metasedimentary" while the amphibolites, and the majority of the granulites of the Imataca Complex are meta-igneous.

It would therefore appear that the Kanuku Complex represents segments of reworked basement, not dissimilar to the high-grade belts of Africa (Kroner, 1977). The paucity of basic rocks, and the prevalence of rocks of granodioritic composition, coupled with a variable Sr87/Sr86 ratio of 0.7016 to 0.7064 indicate that crustal reworking of previously high-grade areas, with minimal mantle tapping were operative in the Trans-Amazonian event. The greater preponderance of biotite gneisses, and their obvious greywacke-shale parentage would therefore infer that the Kanuku Complex is essentially metasupracrustal in origin.

BASINAL SEQUENCES

As indicated in the last section, at least three distinct basinal sequences are present within the Guyana shield. These basins are rimmed by the high-grade rocks described in the last section, and by granitoid rocks of the PreCambrian basement, as in Surinam and French Guiana. These basinal sequences are typically shallow to intermediate water depth meta-sediments intercalated with acid and basic volcanics, all metamorphosed to a greenschist-lower amphibolite grade of metamorphism.

In Guyana, two basinal sequences are identified. One to the north of the Kanuku Complex, containing the meta-sediments and volcanics of the Barama-Mazaruni Supergroup and the other to the south, acting as a depository for Kwitaro Group meta-sediments and volcanics. The Barama-Mazaruni Basin shows signs of shallow marine sedimentation, while the Kwitaro Group is more representative of a shallow, epicontinental sequence of rocks. (See Fig. 7).

THE BARAMA-MAZARUNI SUPERGROUP OF THE NORTHERN BASIN

The Barama-Mazaruni Supergroup represents the lowermost recognizable set of supracrustals in Northern Guyana. Its lithologic characteristics at some localities, coupled with its generally low metamorphic grade, have for a long time, induced speculative correlations with other greenstone belts of the world. Gibbs (1977, 1978) has now put much of that speculation to rest by his recognition of a pervasive greenstone lithostratigraphy in Northern Guyana.

The stratigraphy, simply summarized, from bottom to top is as follows:

- (i) Predominantly mafic volcanics with minor amounts of detritals and chemical sediments.
- (ii) Differentiated, calc-alkaline volcanics, intercalated with chemical and to a lesser extent, detrital sediments. Volcanics are typically of acid to intermediate nature.

(iii) Sedimentary sequence with abundant detritals, subordinate chemical sediments, and acidic to intermediate volcanics.

Notably absent, or present in only very minor amounts, is the characteristic ultramafic-mafic assemblage which is present in the lowermost levels of the type Greenstone belts, such as the Barberton Range of South Africa, the Kalgoorlie System of Australia, the Dharwar System of India, and to a lesser extent in the Abitibi and Yellowknife districts of Canada.

The Supergroup is divided into a northern Barama Group and a southern Mazaruni Group. Though Gibbs (1977, 1978) has indicated the relative similarity of the stratigraphy in these two areas, their geographic separation, the intervening structural complexities, and the ubiquitous presence of manganiferous horizons in the northern sector as opposed to its virtual absence in the south, are sufficient reasons for their retaining individual group status. The southern limit of the Barama Group will be represented by the southern limit of the Barama-Aranka Complex of granitoids, gneisses and amphibolites to which it is genetically related. Its spatial distribution is therefore from the northern top of Guyana, where Barron (1975) described essentially mafic metavolcanics, to an area just north of the east-southeast trending Cuyuni River.

The Barama Group is composed of a lower unit of metavolcanics and metasedimentary rocks, which locally are known as the Tenapu formation in the central Barama Belt.

Units 1, 2 and 3 in the Baramita area (Gibbs 1978), and the Aravanta Formation in the Barama River area. The mafic metavolcanics are in the lower 2/3 of the section, reaching thicknesses of up to 5 km in the central region. The mafic metavolcanics are now principally represented by amphibolites, and greenschist facies meta-basalts, while the meta-sediments with which they are associated span the range of meta-tuffs, quartzitic metacherts, metapelites, meta-arenites and meta-rudites, with the former two being more prevalent in the lower sections, while the metamorphosed detritals typically occur in the upper sections of the sequence.

The middle unit is characterized by manganiferous pelitic, and cherty rocks (Westerman, 1969, 1970) which are known in specific localities as the Matthews Ridge Formation, and the Pipiani Formation further to the south. The pervasiveness of manganese in this unit is one of the basic differences beteen this group and the Mazarani Group to the south.

The upper unit is typically composed essentially of fine grained metasediments with intercalations of acid, intermediate and basic volcanic flows and tuffs. The meta-sediments, which carry rounded zircons and tourmaline, are interlayered with manganiferous mudstones which are associated with phyllites, quartzites, chlorite schists, amphibolites and psammitic schists (Cannon and Bramley 1960, Williams et al 1967). These metasedimentary rocks are generally multicoloured in outcrop while the metavolcanics are represented by green chlorite schists and amphibolites.

This unit is known in specific localities as the Arakaka and Kokerite Formations, of course, reflecting the name of proximal areas.

The description of the Middle and Upper units is what was typically given for the Barama Group by Cannon and Bramley (1969), Williams et al 1967, and numerous workers of the sixties. However, Gibbs (1978) demonstrated that the original views of Connoly (1925) and Bracewell (1942) were correct, and has therefore established the great importance of the lower, principally mafic volcanic, member.

Significantly also is the identification of greywacke, and conglomeratic horizons intercalated with differentiated, principally acidic to intermediate, volcanics in the upper sections of the Barama Group. Williams (1961), et al (1967), considered these to be the typical rocks of the Mazaruni Group to the south, and used it as a basis for their stratigraphic nomenclature. As will be seen in the description of the Mazaruni Group rocks, this division is unwarranted.

In 1963, J. Carter identified three units in the Kaburi area, and though their relative ages were uncertain, similar successions were mapped in the entire region from the Cuyuni River to the Potaro River - the latter being considered as the southernmost extension of the Mazaruni Group. These units were:

(i) Mainly basic to intermediate volcanics.

(ii) Mudstones, greywackes, pebbly sandstones and conglomerates with minor mafics.

(iii) Mainly acid to intermediate volcanic.

This sequence was recognized at Issano (Cannon 1963), at Karanong (Hewins 1974), at Aranka (Fernandes 1963), and recently by Gibbs (1977) in the Puruni region, where he determined the relative ages.

The stratigraphy from the bottom to the top is given by Gibbs (1977) in his statement that:

> "Unit I comprised predominantly of metabasic rocks, including metababbros, metadolerites, metabasaltic tuffs and tuffites with subordinate metamorphosed cherts and more felsic rocks. This unit is apparently conformably overlain, and possibly marginally interlayered with Units II and III, which are demonstrably and substantially interlayered with each other. Unit II consists of the differentiated, largely pyroclastic metavolcanics, but also includes the shallow intrusives, flows, minor interflow sediments associated with the differentiated volcanics. Unit III consists of metasediments principally derived from the volcanic and subvolcanic rocks of Unit II."

The sedimentary beds are normally graded and typically do not form units in excess of a foot. The clasts are extremely poorly sorted and are composed of quartzites, phylites, and subrounded fine grained igneous rocks while the matrix is essentially quartz, feldspar, chlorite, sericite, epidote and pyrite cubes (Williams et al 1964). The fine-grained porphyritic rocks are typically soda-rich, while bearing clasts of sodic plagioclase, orthoclase, quartz, occasionally hornblende, with secondary epidote, calcite, and chlorite (Williams et al 1961, 1967), and like most of the rocks, display tremendous degrees of hydrothermal alteration. Pillow structures are common, hence atesting to the subaqueous origin of this formation.

With the Mazaruni Group defined in this fashion, it then becomes a simple matter of assigning local formational names to specific units depending on their occurrence, and continuity. It is therefore consistent to identify the Haimaraka and Western Cuyuni formations as essentially representing the sedimentary greywacke sequence of Unit III in the western part of Guyana between latitudes 6^{o}N and 7^{o}N. Similarly, they overlie the Makapa formation of differentiated metavolcanics, metasediments, (Williams and Bailey 1961, Hamilton 1952), which can be considered as occurrences of Unit II. Barron's (1975) Noseno formation near Akarabisi, and the Arawai formation further south in the Wenamu district, are typically amphibolitic (after mafic metavolcanics) and as such, are representatives of Unit I.

In the central part of the Mazaruni Group, it is also then conceivable to identify Unit I of predominantly mafic metavolcanics as the Tiger Creek Member, because of the outcropping as described by Gibbs (1977) in this area. Unit II can be called the Aremu Member because of its ubiquity in the catchment area of the streams servicing the Aremu River. Together they make up the Puruni Formation, while in the Cuyuni section, Gibb's Waikuri Series can be identified as the Waikuri Member of the Central Cuyuni Formation of differentiated metavolcanics. Similarly, Unit III of metasediments can be called the Mara-Mara Member of the Puruni Formation based on the description given by Guardia (1968).

Any lithostratigraphic classification should have as its primary aim, the identification of features which present the geology of the area as an integrative whole. Since, there is general conformability of the three units, it is therefore unnecessary to identify Barama and Mazaruni Groups by a subdivision of the strata. Particularly in the case of Guyana where the main objective of geological activity is to seek exploitable deposits, the integrity of the greenstone association is disrupted by the artificial divisioning of the strata as was done in the Geological map of Guyana (McConnell 1962).

J. Carter and Fernandes (1969) recognized this fact and they proposed the demotion of the Barama from group to formation status. Their recommendation was based on the observations that the Cuyuni Formation (formerly of the Mazaruni Group) succeeds conformably the Barama manganiferous quartzites, phyllites and chlorite schists. Secondly, the manganiferous deposits at Tenapu, Arakaka, Matthews Ridge, Saxacalli and Pipiani-Tassivini which were considered to be distinct groups of rocks, and which were considered as formations in the original "Barama Group" were thought to be all on the same stratigraphic level from the works of Fernandes (1963), Matthews (1951), Webber (1952). Similarly, the works of Barron (1960, 1961), and quite particularly that of M. Carter (1959, 1962) proved without much doubt that the Muruwa and Iwokrama Formations are structurally and compositionally so different from the Cuyuni and Haimarka rocks that they should be removed from the Mazaruni Group. Hence, it was proposed that the Barama - Mazaruni Assemblage (McConnell 1962, 1964, Williams et al 1969) of the old provisional map should be changed to the Barama - Mazaruni Group.

Though Carter and Fernandes' proposal has tremendous merit, and is rather similar to that of this thesis and Gibbs (1977), it ignores a large number of obvious complexities, and many impediments to successful correlation. It is the view of the author that the subordinate units (member) of the Carter-Fernandes proposal are too variable, and hence not reliably amenable to correlation. Hence, formation status is retained for their members. The rationale of course being that sequences can be correlated, while member variability can be accommodated. It is true that the Carter-Fernandes model could use super- and submembers with the same effect, but this thesis prefers the Super Group, group, formation, classification, as is done in many greenstone belts of the world.

Gibbs (1977) on the other hand, recommends the formation of a Cuyuni Group and a Puruni Group which are time equivalents of the Barama Group, but in different geographic locations. In view of the limited size of the area, and the overall recognition of similar features in the Cuyuni and Puruni, it is my opinion that such further-group classification is unwarranted. In this dissertation, the Mazaruni Group includes all the rocktypes described between the Cuyuni and Potaro Rivers.

The uppermost sandstone horizon of the metasedimentary unit is thought to conformably underlie a sequence of purple, mauve and pink mudstones with minor conglomerates, sandstones, siltstones, shales, slates and tuffs, which together make up the Haimarka-type Formation (Connoly 1925, Hawkes 1961, Williams 1961, Williams et al 1967). Bateson (1965) also describes the occurrence of accretionary lapilli and volcanic shards which could only have been derived from a terrestrial source, such as the continental volcanics of the neighbouring Iwokrama Formation, hence indicating that Haimarka times which saw deposited up to 8000 feet of mudstones in the Issineru River area must be contemporaneous with the laterally placed Burro-Burro Group, which will be discussed below as a shelf sequence. Secondly, it could also be interpreted that in Haimaraka times, both subaqueous and aerial volcanics could have been produced, indicating that conditions were very shallow. Gibbs leads evidence to this end in the Puruni area.

Barron (1964) records what he considers as an angular unconformable surface on metagreywackes and basics below the Haimarka formation in the Cuyuni River near Makapa. This unconformity is of limited extent, and confirms the notion that shallow water to subaerial volcanism must have been present, as during the periods of quiescence, erosion must have taken place.

The Barama-Mazaruni Super-group has been openly folded about northwest - southeast axes which have been subsequently refolded about northeast - southwest axes. The Group is impressed with a pronounced sub-vertical cleavage and foliation, and typically metamorphosed to the greenschist grade with locally higher grades where intrusive granites and later basics raise the grade to the amphibolite facies (Williams 1961, Williams et al 1964, Cannon 1964). North of Peter's Mine, there is a structural break (Million Mountain Break) which trends east-northeast, and which separates two structural styles as well as rocks of typical Cuyuni greywackes to the south and more basic rocks to the north. The northerly trending rocks at Peter's Mine to the south give way to northwesterly trends north of the break (Barron 1969). This break was interpreted by Barron (1969) to be an unconformity, and of local extent (Barron, personal communications 1978). However, this is a much more pronounced feature on the aeromagnetic maps, and it will be discussed further in the section on the Bartica Assemblage and its relationship to northern Guyana tectonics. Another imposing structural feature is north-westerly trending Kuribrong-Makapa Shear Zone which cuts the entire group except for the Morabisi granites. The significance of this shear zone which is composed of schist and phyllonites is "unknown" (Barron 1969) and will be discussed in a later section.

THE BARTICA ASSEMBLAGE

Three large bodies of amphibolite grade gneisses are present in Northern Guyana. The gneissic complexes are referred to as the Bartica Assemblage, after the major occurrence which is centred at Bartica, a town at the confluence of the Essequibo, Mazaruni and Cuyuni Rivers. The other two occurrences are in the Barima-Whanamaparu area (hence Barima-Whanamaparu Gneisses), but referred to as the Barima-Amakura Complex by Gibbs who includes the Barima-Amakura Granitoids, and the central portion of the Cuyuni River at Devil's Hole (hence Devil's Hole Gneisses), which is referred to as the Barama-Aranka Complex by Gibbs, who includes the Aranka Granitoids in the category.

The Bartica Assemblage has been divided by Cannon (1961, 1964) into five distinct sets of rocks, namely:

(i) Biotite Gneisses
(ii) Hornblende-biotite gneisses
(iii) Amphibolites
(iv) Porphyroblastic gneisses
(v) Muscovite-biotite granites

Of these, the biotite gneisses and the hornblende-biotite gneisses are the most prevalent, and may have transitional forms interlayered between them. The biotite is occasionally mantled by muscovite, and in some cases in such proportions to form biotite-muscovite gneisses. The porphyroblastic variety is similar to the biotite gneisses except for the presence of porphyroblastic K-feldspar, while larger areas of amphibolites form semi-conformable masses within the hornblende-biotite and biotite gneisses.

All the rocks except a later biotite-muscovite granite as Kartabu Point, are intruded by grey-pink biotite granites which occur as dykes of variable dimensions (x10 -- x 100 m) with sharp contacts (Cannon 1961, 1964, Williams et al 1967). The amphibolites will prove to be of interest (see Chapter 7) and are essentially composed of over 50% hornblendes in a granulitic matrix of andesine and quartz, which together increases the banding when found in larger amounts in adjacent bands. Variable amounts of clino-and ortho-pyroxene can be seen, especially acting as covers to hornblendes, and plagioclases. Accessory sphene, epidote, apatite, pyrite and opaques are characteristically present (Cannon 1964).

The gneisses lie within the epidote-amphibolite to the almandine-amphibolite facies, with a few sections approaching the amphibolite-granulite facies boundary. Cannon (1964) considers that the banding is principally a result of tectonism and was later accentuated by metamorphic segregation and metasomatism. Lithologically, the Bartica Assemblage leucocratic and melanocratic banded rocks could be derived from the phyllites, greywackes, quartzites and volcanics of the Barama-Mazaruni Supergroup. The biotite granites, leucocratic facies of the Bartica assemblage, and the numerous syn-and post-kinematic aplites and pegmatites that intrude the rocks are considered to be anatectic products formed at the root zone of the Barama-Mazaruni supracrustals.

The micro, macro and regional banding are all related to the foliation which parallels the axial planes of folds defined by a first deformation period. These first period effects have been deformed by secondary tectonics which superimposed on it, steep, westerly plunging (30 - 50°) fold axes with steep axial planes. (Cannon 1961, 1964). Of the four sets of joints (NE, NNW, NW, E) ifentified, the north-northwest and east-west ones are more dominant.

Transitional between the Bartica Assemblage and the Barama-Mazaruni Group is a zone of altered basic and siliceous rocks with abundant amphibolites and subordinate quartzites and schists. These rocks are called the Marginal facies rocks of the Barama-Mazaruni Super-group by McConnell (1961) and Williams et al (1967), and they are very common around the Devil's Hole Gneisses and the Barima-Whanamaparu Gneisses. Their ubiquity, the common presence of amphibolites (after basics no doubt) and their relatively straight boundaries coincident with other major observed cleavages, is certainly a point of tremendous interest. It is in this connection that the Million Mountain Break considered by Barron (1969) (person communication) as an unconformity takes on added significance.

Cannon (1964) postulated that the amphibolites may be tectonically emplaced along dislocation zones during the first period of deformation. This conclusion was based on an observed faulted, cataclastic contact between the Bartica Assemblage and the Barama rocks at Saxacalli, coupled with Carter's (1963) observation that the eastern margin of the Devil's Hole Gneiss is fault controlled. It is certainly significant that a projection of an extensive fault surface defined by Kalliokoski (1965) between La Paragua and El Callao in Venezuela projects right at the northern contact between the Barima-Whanamaparu Gneisses and the Barama Formation. This proposition is further substantiated by Gibbs' observation that the northern limb of the Barima Syncline which bears the Barama group rocks, is truncated. The zone just north of the Barama rocks is characterized by a relatively high gamma reading according to the Residual Magnetic Map of Hood and Tyl (1973) and its magnetic signature does not correlate with the rocks to its north and south. This prompted Gibbs to infer a deep seated source, which in all probability reflects the major cleaved zone extending from Venezuela.

One cannot also overlook the fact that the Million Mountain Break is proximal to and parallels very closely, a highly east-north easterly trending zone - the Supenaam lineament - defined by numerous younger basic intrusives, an aeromagnetic lineament, and the very straight course of the Supenaam River. Gibbs notes intense cataclasis in what can best be termed a shear zone, and in which an almost straight succession of four copper-nickel prospects are located. Like the break on the northern limb of the Barima Syncline, he notices some signs of dextral movement.

The inference therefore, and one which has tremendous potential for mineralization assessment is that the Million Mountain Break, and the break found north in the Barama rocks, are deepseated fault structures along which mantle material might have been tapped. The pervasive presence of amphibolites in these zones could be explained either by Cannon's mechanism of tectonic emplacement of mantle material, or it could be vertical tectonics which cause the juxtaposition of predominantly mafic rocks of Unit I next to more differentiated and epiclastic sediments of Units II and III.

GUYANA SHIELD CORRELATIVES OF THE BARAMA-MAZARUNI GROUP

The Barama-Mazaruni rocks are definitely post Imataca (2720 Ma), and they generally give ages between 2200 Ma and 1800 Ma, based on the granites intrusive into them (Snelling et al 1969, Hurley et al 1976, Gaudette et al 1978). This sequence of mafic metavolcanics followed by differentiated metavolcanics intercalated with meta-greywacke and meta-ferruginous cherts, and finally topped by epiclastic meta-sediments, has been correlated with the Carichapo and Pastora groups of Venezuela (McConnell 1970, Williams et al 1969, Kalliokoski 1965). The recent reappraisal by Gibbs of the Barama rocks, and the establishment of a pervasive lower meta-mafic horizon removed some of the difficulty that past correlations of the Barama of Guyana with the Carichapo of Venezuela suffered. However, the Carichapo is known to have a significant ultramafic component, which is yet to be unambiguously proved in Guyana. The attempts by Dougan (1976) to further complicate the problem by asserting that the Carichapo might be pre-Imataca, based upon some structrual work, has since been removed due to regional relationships and some dating by Gaudette et al (1978).

In Table 28, the other shield correlatives are presented and it is noted that the Barama-Mazaruni Supergroup is correlated to the Marowijne Group of Surinam, to the Paramaca-Bonidoro-l'Orapu assemblage of French Guiana, the Villa Nova, Cauarane and Tunui assemblage of Brazil north of the Amazon River, and finally it corresponds to the upper and lower Birrimian of West Africa. All of these sets of rocks

Table 28

Summary of Correlatable Units in the Guyana and West African Shields

Venezuela	Guyana Northern	 Southern	Suriname	French Guiana	Brazil North of Amazon River	West Africa
Middle Proterozoic Roraima intrusive suite	Roraima intrusive suite(mafic; 1,600 to 1,700 m.y.)		Roraima intrusive suite (mafic)	Roraima intrusive suite	Roraima instrusive suite	
Roraima Group	Roraima Group		Roraima Group 1,600 to 1,700 m.y.)*	Dolerites	Roraima Group	
	Unconformity					
	Younger Granite groups* ° (2,000 m.y.)	South Savanna Granite (1,900 m.y.)	Granites (1,900 m.y.)	Granites (1,800 to 2,100 m.y.)	Anorógenic magmatism (?) <1,890 m.y.	Granites (2,000 m.y.)
Lower Proterozoic Pastora-Carichapo assemblage (to east of Caroni River)	Barama-Mazaruni supergroup	Kwitaro* Group	Marowijne Group	Paramaca-Bonidoro-l'Orapu assemblage	Villa Nova, Cauarane, and Tunui assemblage	Upper and lower Birrimian assemblage
Archean Supamo Complex	Makarapan Granite (?)	Kanuku Complex	Bakhuis Mountains granulites	Ile de Cayenne Complex	Complexo Guianense (including granulites)	Liberian orogeny basement (2,700 m.y.)
Imataca Complex						

* From Berrangé (1976).

° From Priem and others (1973).

Sources: After Gaudette et'al. (1978), McConnell and Williams (1970), Martin F. (1974).

typically display the lithologic pattern as described for the Barama-Mazaruni Super-group.

THE KWITARO GROUP OF THE SOUTHERN BASIN

The following description of the Kwitaro Group rocks of the Southern Guyana Basin draws heavily on Berrange (1977), Singh (1966), and Barron (1962) who have been the principal recent investigators in this area. Where necessary, it will be supplemented by references to older accounts at specific locations, and to my own observations in the field.

The Kwitaro Group is made up of five distinct pelitic and semipelitic metasedimentary groups of rocks which are separated from each other by the batholithic South Savanna Granite. The sequence of biotite-muscovite phyllites, metasiltstones, schists and gneisses which have been metamorphosed to the middle-lower Amphibolite facies with a mineralogy of quartz-microcline-oligoclase-biotite-muscovite ± (sillimanite, cordierite, garnet). They are definitely 2-mica schists and gneisses which are interbedded with quartzites and stretched pebble conglomerates locally but have extensive intercalations of para-and ortho-amphibolites (the former being more abundant).

Berrange (1977) coined the name Kwitaro Group to replace the Marudi Group of McConnell (1958), Barron (1962) and Singh (1966), because the Marudi was found to be one of five metasedimentary sequences which may have infilled a common basin which was subsequently granitized, or were five separate but contemporaneous basinal sequences. The Group is now divided into the Dampau, Marudi, Lumidvau, Oronoque and Wakadanawa formations. Apart from the presence of amphibolites, their 2-mica component, the presence of quartzites, and metamorphic facies, the five formations show a highly variable degree of migmatisation which is directly related to the presence of intensive granitoid contacts. For example, the Dampau formation which is marginal to the South Savanna Granite is highly migmatised and has augen gneisses interlayered in a nebulitic, streaky migmatite, while the Wakadanawa Formation which has a contact with later volcanics of the Kuyuwini Group is only slightly affected. The observed general trend is: biotite - muscovite gneiss → biotite- muscovite agmatitic gneiss → augen gneiss containing megacrysts of perthitic microcline as one approaches the granite from the host sediments.

The quartzites, which are most abundant in the Wakadanawa formation are often magnetite-bearing, especially in the Marudi formation where a quartzitic horizon has up to 5% disseminated magnetite. The Marudi formation which is auriferous, also contains abundant orthoamphibolites (after mafics) as well as paraamphibolites. The Oronoque Formation in the east is seemingly the most calcareous of the formations, and its highly variable assemblage gives a metamorphic mineral assemblage of actinolite, sphene, tremolite, diopside, apatite and magnetite.

Palimp-est cross-and graded-bedding are preserved in some of the sedimentary units, and in cases of a high degree of migmatisation, a gneissic layering or foliation follows the original stratification. Fold patterns as discovered at the Marudi Mine reveal an original F_1 folding with northeast trending fold axes which have been refolded like the rocks in Northern Guyana along a later northwest axis. The fold structures are commonly flat but are steep in areas.

The Kwitaro Group, like the Barama-Mazaruni Super group in the Northern Guyana Basin has been deposited on the Kanuku-Supamo Complex during a period of relative quiescence that followed the uplift and tectonics of the Imatacan event dated at 2770 Ma (Hurley et al 1976). K-Ar age determinations on biotites and wholerock from the Kwitaro Group gave an age of 2090 ± 42 Ma which corresponds to the Trans-Amazonian reactivation of the rocks in Venezuala, northern Guyana, Surinam, French Guyana and Brazil. This event which will be put in its correct perspective in the concluding section of this chapter was essentially one that thoroughly affected the Guyana rocks, while resetting the radiometric clocks.

It should be noted that the above lithologic description of the Kwitaro Group does not fit the greenstone model as described in northern Guyana. From Berrange's (1977) description, one can only infer that this sequence of rocks is only comparable to the upper greenstone sequence. The description best fits the model of a shallow epicontental, or nearshore marine environment in which pebble conglomerates could accumulate and limestones develop as in the Oronoque formation. The nature of the detritals, and the age relationships described, would infer that these supracrustals were primarily derived from the Kanuku-Supamo basement which was activated by the 2800 Ma Imataca event.

In this setting, differentiated volcanics were deposited, and they are found intercalated with the rest of the sediments. Unlike the differentiated volcanics of the northern basin, where spilitization was common, in this case no clear record of such a process has been documented. Hence, while the Barama-Mazaruni Basin is considered shallow marine, the Kwitaro Basin is considered to be shallow and epicontinental.

SHELF SEQUENCES

After a brief hiatus in the Trans-Amazonian event, where uplift must have occurred, a period of shelf sedimentation and subsequent intense volcanism (principally aerial) was ushered in. This break in sedimentation was documented by an unconformity by Barron (1963), M. Carter (1962) and Inasi (personal communication, 1978). Because of this break and the difference in structural style between the relatively undeformed Muruwa rocks above and the Mazaruni rocks below, Barron (1963) recommended that the Muruwa and the overlying Iwokrama volcanics and intrusives be grouped together and taken out of the Mazaruni Group of McConnell (1962) and Lloyd and Williams (1961).

Berrange (1977) coined the name Burro-Burro Group which includes the Iwokrama Formation of acid to intermediate lavas, Iwokrama Intrusive Suite of the related subvolanics (adamellites - granophyres - feldspar porphyry) and the Muruwa Formation of orthquartzites. In Southern Guyana, a related volcanic-subvolcanic-intrusive suite is called the Kuyuwini Group which overlies the Kiwtaro Group in a similar way as the Burro-Burro Group overlies the Barama-Mazaruni. (See Fig. 7)

The Muruwa Formation is a sequence of medium-grained, clean sandstones (now orthoquartzites) with jaspers which has minor local occurrences of mudstone, and vitric crystal tuffs (Carter 1961). It extends from the Eagle Mountain area on the Potaro River to as far south as the Turtle Mountain on the Essequibo River. Inliers of the Muruwa Formation can be seen through the Tertiary and Recent cover in the Berbice and Corentyne areas (Carter 1961, Barron 1966, Carter and Fernandes, 1969). Because of the presence of volcanic lapilli which have been recognized in both the Haimarka Formation and in the Muruwa, the latter was considered as the time equivalent, and stable shelf facies of the mainly pelitic Haimarka Formation (McConnel and Williams 1970; Williams et al 1967). This relationship is quite possible and is given more credence by the unconformity mapped by Barron (1964) at the base of the Haimarka at Makapa on the Cuyuni River. However, Cannon (1964) favours a faulted contact to explain the Cuyuni-Muruwa Relationships. The Muruwa rocks are only mildly metamorphosed and are overlain by the Iwokrama Formation.

The Iwokrama Formation and associated intrusives outcrop south of 4° 30' N latitude and extend to the contact with the Takatu rift sequence. The formation is made up of acid-intermediate tuffs and lavas with minor, interbedded shallow water current bedded sandstones and mudstones (Carter 1961, Berrange 1973, 1977). The volcanics are composed of pyroclastics and flows; the former represented by ignimbritic and lithic tuffs bearing high temperature quartz, antiperthitic albite, perthitic orthoclase, in a matrix of quartz, feldspar, sericite, opaques, epidote biotite, calcite and sphene mantled by leucoxene. The welded tuffs characteristically show a eutaxitic texture, while the poorly sorted lithic tuffs carry fragments ranging from 1mm to 3cms (Berrange 1977). The interbedded arenaceous sediments are metamorphosed to orthoquartzites and quartz-sericite-schist. The flows are represented by rhyodacite and andesite with very minor amounts of rhyolite per se.

The rhyodacites contain abundant phenocrysts of blue quartz, altered orthoclase, and fresh twinned albite in a matrix of quartz, feldspar, sericite, leucoxene after sphene, opaques, calcite and piedmontite. The highly-altered, green feldspar-phyric andesites containing highly saussuritized andesine phenocrysts, along with pistacite-pseudomorphing pyroxene, and leucoxene rimming opaque oxides, are the most basic volcanics found in the sequence (Berrange 1977).

The Iwokrama Intrusive Suite is a conglomeration of bosses, stocks, dykes, and sheets that havebeen emplaced at a high level. They are essentially composed of adamellites, granophyres and feldspar porphyries which are related to the Iwokrama volcanics into which they intrude (Carter 1961, Berrange 1973, 1977). Typically, they are highly differentiated showing lateral as well as vertical gradations. Berrange (1977) records lateral variations from "aphanitic sparsely feldspar-phyric rhyolite through fine grained feldspar porphyry to granophyres", and vertical variations from rhyodacites at a high level through feldspar porphyry and granophyres and subsequently adamellites at lower levels. The pink, medium grained, adamellite containing approximately equal amounts of quartz, orthoclase, and sodic plagioclase forms the major plutons, and like the volcanics, it is characteristically highly altered with an accessory mineral assemblage of penninite, pistacite, apatite, primary and secondary sphene. The granophyres form small plutons or are peripheral to the adamellites, and typically show granophyric texture of quartz with K-feldspar which form a matrix to phenocrysts of perthitic orthoclase, sodic plagioclase and occasionally to fluorite as at Jauri Creek (Berrange 1977, Carter 1961). Carter (1961) also describes dolerite dykes cutting the volcanics, and the dykes in turn being intruded by sub-volcanic intrusives, hence indicating that there was a hiatus between outpouring of volcanics and intrusion of granophyres and adamellites.

The Iwokrama volcanics and intrusives, like the Muruwa Formation which underlies it, are openly folded with steeply-dipping, easterly-trending axial planes. Later fracturing has opened up northeasterly-trending joints which have been intruded by metadolerite dykes. Plutonism accompanied by numerous pegmatites, aplites, and quartz veins next occurred, while the entire sequence became metamorphosed to the greenschist grade. Note must be made of the intensity of the hydrothermal process (essentially deuteric), which is responsible for the great amount of secondary alteration minerals identified.

In Southern Guyana, a similar set of volcanics and intrusives as described for the Iwokrama is present (Barron 1961, 1962, 1969; Hardwick 1954; Berrange 1973, 1977). These rocks are collectively referred to as the Kuyuwini Group (Barron 1969), and have been further subdivided into local formations and intrusives by Berrange (1973, 1977) who has identified the volcanic formations at Watu Falls, Sipu River, Kamoa River, and Dead Man Ridge. He further distinguishes the Amuku, Kamoa, Maopityan, and Onoro intrusive suites. These rocks are arranged along narrow east-trending belts which are defined by the preferentail erosion of the less resistant volcanics, which act as channels for the major rivers, while the resistant intrusives form ridges.

The volcanics which vary slightly in composition, are typically dark-grey, aphanitic plagioclase-pyroxene-phyric dacites, with intermediate plagioclase, clinopyroxene, set in a fine grained matrix of quartz, K-feldspar, plagioclase and opaques. When the rock is intensely altered as in the Kamoa River and Dead Man Ridge formation, it becomes a grey, aphanitic, plagioclase-quartz-phyric rock in which biotite, epidote, sericite, calcite are added to the matrix. Also occurring are welded crystal tuffs, and agglomerates, especially in the southern-most Sipu River Formation, and ash-fall tuffs as occurs in the Kamoa River Formation to the north. These tuffs typically contain corroded and saussuritised plagioclases of sodic to intermediate composition, epidote pseudomorphing pyroxene and opaques (Berrange 1977). Some occurrences as on the Sipu River are pale grey, while others as on the Chodikar River to the south are dull red, and they are locally banded and streaky.

The volcanics are interbedded with small amounts of sediments as at Kamoa River Mouth where calc-silicates, mica-schists and paragneises are present, and there are cases where Kwitaro Group metasedimentary rocks occur as inliers in the younger Kuyuwini rocks.

The subvolcanic intrusives range from the deep level pink, medium to coarse grained biotite granite, adamellite, of the Kamoa mountains to the higher level plagioclase-pyroxene-phyric granophyres and porphyries of the Amuku Intrusives in the Acarai Mountains. The Amuku Intrusives show the entire trend from deep level biotite-hornblende adamellites to higher level medium grained granophyres. The Yukanopito Intrusive of dark-grey, biotite pyroxene ± (hornblende) granodiorite which intrudes the Watu Falls volcanics is seen to be clearly a subvolcanic associate~~, on~~ account of their similarity in mineralogy. It contains, like the Onoro Mountain granite, a distinct assemblage of blue opaline quartz and/or large poikilitic plates of biotite, which are intermixed with variable amounts of quartz, intermediate feldspars, microcline, biotite, hornblende, hypersthene and augite or their altered derivatives. This granodiorite resembles the Marudi Granodiorite which is thought to be connected to the gold mineralization in Marudi metasediments, which it intrudes (Berrange 1973, 1977; Barron 1962). Apart from the zonation with respect to level of intrusion, the Kuyuwini intrusives and volcanics are chemically highly differentiated, and the Maopityan Granophyre which has the highest differention index (D.I.= sum of percentages of normative quartz + Orthoclase + albite) of 96 is considered to be late stage residual magmatic differentiates of the granito-volcanic system (Berrange 1977).

The Kuyuwini rocks like those of the Burro-Burro, are only slightly metamorphosed to the greenschist facies, which may have developed on account of the later intrusives in the case of the volcanics, or due to regional effects or both. In Dead Man Ridge Formation, intense shearing and faulting has impressed its own metamorphic effects on the minerals, which are a mixture of epidote, chlorite and secondary minerals. The phenocrysts in the volcanics are characteristically embayed, and their generally altered form may be attributed to intense hydrothermal activity which typically explains an assemblage of opaline quartz and pistacite.

Folding is tight to close, and a steeply dipping axial plane cleavage, and tectonic foliation are developed. The pervasive easterly trend of the major ridges, troughs and lithology is also the major fracture direction. The Amuku intrusives, Watu Falls volcanics, the Yukanopito Intrusives and the highly differentiated Maopityan Granophyres have been affected by a plethora of fractures which have strong northerly, and northwesterly trends. This is a rather interesting area from the standpoint of its tectonic preparation for mineralization. It is not certain how deepseated these fractures are, but the discussion by Berrange concerning inhibition of eutectic micropegmatites in the granophyres by rapid cooling would seemingly indicate that these fractures may be shallow level features caused by tectonic readjustments in a chilled outer rind. Their significance to mineralization will be investigated closely in the next chapter.

The Burro-Burro and the Kuyuwini groups clearly represent shelf facies environments and their recognition has been instrumental in the definition of the limits of the basins. (McConnell and Williams, 1970). The Kuyuwini and Burro-Burro Groups may be time equivalents as given by Rb:Sr radiometric ages of to 1900 ± 150 Ma for the Burro-Burro (Berrange 1977). A comment should be made on the wide scatter of Rb-Sr ages which Rundle,Snelling and Chan (1972) computed for the Kuyuwini rocks, in view of their interpretation of the 1454 ± Ma, 1322 ± 28 Ma K-Ar ages which they computed, and which was attributed principally to argon loss as a consequence of the 1200 Ma K'Mudku episode by Berrange (1977). Though this is highly likely, the 1454 ± 30 Ma age, coupled with the dating of the Roraima Intrusive suite at 1536 ±.50 Ma by Snelling and Berrange (1970) may well reflect the 1500 Ma Paraguazan event dated in the upper Amazonas Basin to the south by Martin-Belliza (1972), and which event is being found in the Brazilian portions of the Guyana shield, south of the border (Kovach et al 1976), and in the rapakivi granites of Venezuela (Gaudette et al 1978).

The Iwokrama volcanics and intrusives are recorded in Brazil as the Surumu Formation (Amaral et al 1970). They proceed northwesterly into Venezuela to an area west of Rio Caura into the Cuchivero acid volcanics and intrusives (McCandless 1962), which overlies the quartzites and muscovite schists of the Cinarruco Formation - the obvious correlative of the Muruwa Formation (Kalliokoski 1965, McConnell and Williams 1970). In Western Surinam, the Ston orthoquartzites, which underlie the Dalbana ~~acidic~~ plutonics and volcanics, are the time, lithologic and stratigraphic correlatives of the Muruwa and Iwokrama Formations respectively. This sequence is also found in Central Surinam and in French Guiana.

CRATONIC SEQUENCES

Succeeding the turbulence of the orogenic Trans-Amazonian Tectonomorphic event (1810 Ma) was a period of quiescence during which the flat-lying sedimentary sequence of conglomerates, sandstones, shales, and volcanics was laid down principally in eastern Venezuela, north-eastern Brazil, and western Guyana where it forms the Pakaraima Mountains, with outliers in Surinam (at the Tafleberg) and

and Colombia (Keats 1974, 1973, 1972; Barron 1962; Bateson 1965, 1974; Gansser 1954; McConnell and Williams 1971; Priem et al 1973, Reid 1974). The sequence formerly known as the Roraima Formation is probably 2000m to 3000m thick and was elevated to group status on the recommendation of Barron (1969), who suggested that the identified Upper, Middle and Lower Members be now considered as formations. The Roraima sediments cover approximately 450,000 sq km of crystalline basement in the western part of the Guyana Shield, and reach a maximum thickness of about 2400m in S.E. Venezuela at Auyan Tepui, while receiving its name from Mt. Roraima in Guyana (Fig. 7).

The Lower Formation is essentially a sequence of coarse-grained sandstones and conglomerates, while the Middle Formation is characterized devitrified fine grained felsic volcanics, fine grained arenites and pelites, which grade into the Upper Formation of essentially conglomerates and sandstones. Keats (1973, 1974) has been able to identify nine lithological types in the Lower and Middle Formations, and they are from base upwards:

Unit I - Polymict basal conglomerates
Unit II - Arkoses
Unit III - Quartzose sandstone
Unit IV - Quartz conglomerate
Unit V - Arkosic and quartz sandstones
Unit VI - Silts, shales and fine sandstones
Unit VII - Quartz conglomerates
Unit VIII - Dominantly sand grade sediments

Unit IX - Jasper Sequence

The mainly argillaceous Unit VI of Keates (1973) was shown to be quite extensive by Bateson (1962) who traced it for 144 kilometres and proposed that the top of this unit be considered as the top of the Lower Roraima Formation. Keates (1973, 1974) has been further able to identify the essentially oligomictic quartz conglomerates of Units IV and VII as being the principal sources of the Guyana diamonds which will be discussed in the next chapter. Sedimentalogical evidence indicates that transport directions in these units was westerly, the source being to the east-northeast, while the environment was fluvio-deltaic, to shallow marine.

It is obvious from the succession above that the Units I to IV represents a transgressive cycle, with units V to VII representing a regressive cycle, while VIII and IX show a reversal. Because of the clear indication of sedimentation regimes, that are connected with possible epeirogenic readjustments on the craton, Keats (1972) reference to the sequence as being a molasse is probably inaccurate. This view is also enhanced by the unconformable contact of the Roraima sediments with the underlying sediments and granites of the Barama-Mazaruni supergroup, coupled with the non-interference of the Roraima sediments by the orogenic Trans Amazonian activity (Barron 1969, Snelling and McConnell 1969).

In Venezuela, Units I to IV, representing about 1500m of sediments, are apparently absent (Keates 1973) while Priem's (1973) identification of pyroclastics and ash-flow tuffs at the base of the Tafleberg and in the Lower and Middle Members in Surinam may indicate that the Middle Formation of Guyana coincides with the Lower and Middle Formations of Surinam. Roraima volcanism which may not be unrelated to the large dolerites and gabbroic dykes and sills which intrude the Roraima sediments, may be the source of the silica for the pyroclastics and the red and green jaspers of these comparable horizons (Priem et al 1973, Allen 1967). The late stage granites of the Trans Amazonian event were dated at 1810 Ma and since they unconformably underlie the Roraima sediments, they set a maximum age for the sedimentation process. The intrusive dolerites were dated at 1695 ± 66 Ma by Snelling and McConnell (1969), while Priem et al (1973) in Surinam dated the pyroclastics at 1695 ± 18 Ma, thus setting actual limits to the period of sedimentation which must have been of very short duration.

GRABEN SEQUENCES

South of 4°N latitude, a 65 km wide down-faulted basin known as the North Savannas Rift Valley divides the Early Proterozoic basinal sequences of the north from the Kanuku granulites and migmatites on the south. It extends from the Toucan Hills in Guyana (its eastern margin) to the west for approximately 180 km, thus terminating in the Rio Branco territory of Brazil. This basin is floored by Early Proterozoic rocks which are covered by mid-Jurassic tholeiite sheets referred to as the Apoteri Volcanic Formation; the latter in turn being overlain by an essentially pelitic cover known as the Takatu Formation (Berrange 1973, 1977; Snelling and Berrange 1970; McConnell et al 1969; Van der Hammen and Burger 1966; Wicherts 1965; Bleackley 1962; Bramley 1962; McConnell 1959; Morris 1959, 1962). Snelling and Berrange (1970) coined the name Reva Group to include these two formations which are in turn overlain by the Tertiary and Recent sediments of the North Savannas Formation.

The Takatu Formation, which may be interbedded with Apoteri Volcanics at their lower levels, is essentially a sequence of mudstones, shales, siltstones and arenites. Spatially, the pelites predominate in the west and central regions where they have a relatively high calcareous content, which however does not form any significant recognizable sections of limestone, while the eastern section is more arenaceous. The sediments show various states of oxidation as indicated by the reddish-brown to purple, yellow, green, grey and even black types. Sediment transport was essentially from the north (probably Iwokrama volcanics) as was indicated by Bramley's (1960) study and from the south and north-east (from Kanuku Complex and Essequibo-Corentyne Granites) as given by Dixon (1959).

Palynological studies (Van der Hammen and Burger 1966)on the top 100m of the Takatu Formation gave ages corresponding to the Lower Cretaceous-Upper Jurassic, while K-Ar ages on the underlying Apoteri Volcanic formation give a spread of ages from 114 Ma to 178 Ma (Berrange and Dearnley 1975). The lower Takatu Formation may therefore be up to Middle Jurassic in age, and the intervening time would have been necessary for the laying down of the 4000 to 6000m of sediments thought to be present (Wicherts 1965, McConnell et al 1969, Singh 1972).

The Apoteri Volcanic Formation, which dips at a shallow angle to the centre of the basin, is a sequence of greenish-grey fine grained to aphanitic amygdaloidal tholeiitic basalts. They consist of calcic plagioclase (An 65-70), augite, intersititial glass and numerous opaques, while the ubiquitous amygdules carry quartz, agate, calcite, zeolite, and pyrite. The lavas are frequently observed to be pillowed hence indicating the subaqueous origin for the volcanics. Combined with the lithology of the sediments they underlie, the Rewa Group therefore displays signs of a shallow-water continental or littoral,environment (Barron 1960, McConnell 1959, Berrange 1977).

MAFIC AND ULTRAMAFIC INTRUSIVES

Basically five periods of intrusions by mafics and/or ultramafics have been recognized (Berrange 1977, 1973, Hawkes 1966, Snelling and McConnell 1969, Snelling and Berrange 1970, Priem et al 1973, Priem 1970, Choudhuri and Milner 1971, Singh 1966, Choubert 1974). These are:

(i) Metadolerite Dyke Suite
(ii) Appinitic Intrusive Suite
(iii) Late-Kinematic Dyke Suite
(iv) Roraima Intrusive Suite
(v) Basic Dyke Suite

The oldest of these is the Metadolerite Dyke Suite, which is represented principally by orthoamphibolites in the rocks of the Kanuku Complex, the Southern Guyana and Essequibo Corentyne Granite complexes, the Kwitaro Group, and Barama-Mazaruni Supergroup.They are relics of dykes and sills which have been metamorphosed in the enclosing rocks, and quite notably, they are absent from the younger Kuyuwini and Burro-Burro Groups. Significantly this stage of basic intrusion is nearly completely destroyed in the incompetent supracrustals of Kwitaro and Barama-Mazaruni, since granitisation in an adequate water environment will soon proceed to form diorites, granodiorites, etc., thus explaining perhaps the paucity of the meta dolerite rocks in the low grade supracrustal terrains. This process must have been operative in the south of Guyana where these metadolerites are preserved in the high-grade dry basement Kanuku rocks, but are relatively scarce in the Kwitaro supracrustals.

Next in age are the hydrated late orogenic melanocratic rocks (the Appinitic Intrusive Suite) which are intimately associated with the granite intrusions. They are widespread in Southern Guyana as at Badidiku Mountain, Achiwiib, Tamton Hills, etc., and in northern Guyana, they may be represented by the granodiorites and diorites that are intimately associated with the younger granites and between the middle Barama and Cuyuni Rivers, and east of Devil's Hole on the Cuyuni River. They are typically highly differentiated and can show transitional types between peridotites and quartz diorites. The molybdenum bearing quartz-diorites of the Potaro region may be expressions of this Appinitic Suite, which typically give ages about 1800 - 1900 Ma representing waning stages of the orogenic process.

Berrange (1977) described a Late-Kinematic Dyke Suite of discordant amphibolitic dykes that post-date the main Trans Amazonian event in Southern Guyana, where it cuts rocks of Kanuku and the Granite complexes, and the Appinitic Intrusive Suite. These dykes are presumably of post 1900 Ma age, and are probably also present in Northern Guyana, where most of the basics have been collectively inserted into the Younger Basic Group. The Late-Kinematic Dyke Suite is a mixture of fine-grained, amphibolites, hornblende-biotite quartz microdiorites, and pyribolites which are characteristically foliated, irregularly shaped, and form sharp contacts with the country rock.

Following the Late-Kinematic Dyke Suite is the Roraima Intrusive Suite, which is well represented in northern Guyana where it occurs as dykes and sills in the Roraima Group and underlying rocks (Barron 1966, Snelling and McConnel 1969, Hawkes 1966). Hawkes (1966) was able to trace from Tumatumari a 500 metre -wide dyke which passes westward into the 300 metre thick Kopinang Sill in the Roraima Group. Apart from the dykes that are evident in the older rocks, two very large sills are present in the Roraima Group. Hawkes (1966) was able to distinguish three distinct zones in the Kopinang Sill - the Upper Zone containing hornblende, andesine, quartz, and alkali feldspar, the Middle Zone containing pigeonite, augite and labradorite, while the Lower Zone contains the more mafic members with a mineralogy of orthopyroxene, augite and labradorite. Weak igneous layering, rhythmic layering, and stratiform layering are evident especially in the lower zone of the Kopinang Sill and main zone of the Unconformity Sill to the east. As mentioned in the section on the Roraima Formation, these tholeiitic dolerite-gabbro intrusions give a best K-Ar, Rb-Sr age of about 1695 Ma, hence establishing that they are definitely post Trans-Amazonian, and Berrange (1977) suggests that the event of intense dolerite intrusion between 1500 Ma and 1700 Ma be referred to as the Roraima episode, while attention is here called to its possible relationship to the Paraguazan Event just south of the border in the Amazonas Basin and Guapore craton, and in the rapakivi granites of Venezuela.

A set of tholeiitic dolerites giving Permo-Triassic ages of 180 Ma to 264 Ma intrudes the Guyana Shield, and have been identified in Guyana, Surinam, Venezuela and French Guiana (Hawkes 1966, Priem 1973, Priem et al 1970, Berrange 1977). These dykes which were referred to as the Minor Dyke Suite by Hawkes (1966) have been renamed the Basic Dyke Suite by Berrange (1973, 1977) in view of their ubiquity and large dimensions, especially in the Burro-Burro rocks, in the vicinity of the North Savannas Rift Valley. They generally trend to the north-east in northern Guyana up to about 3^{o}N latitude, while the occurrences further south have marked northerly trend that is associated with a major faulting direction (Berrange 1977). Petrologically, the dolerite is essentially an augite-pigeonite-micropegmatite tholeiite that is typically differentiated.

GRANITOIDS

Granitoid rocks are extensively distributed throughout the Guyana Shield, and as can be seen from the map, they form a large part of the southern regions in particular. For convenience, they may be considered as follows:

(1) Younger Granite Group: those granitoid rocks in northern Guyana which are proven to be older than the Roraima Group, but younger than the Barama-Mazaruni; (McConnell 1962, Cannon and McConnell 1967, Barron 1969, Williams et al 1966).

(2) Southern Guyana Granite Complex - SSG: (the batholithic group of granitoids found south of the Kanuku Complex, while enveloping the Kwitaro Group rocks and lying generally south of the Kuyuwini rocks):(Singh 1966, Barron 1962).

(3) Essequibo-Corentyne Granite Complex:(large granitic batholith found north-east of the Kanuku Complex, and east of the Rewa-Takatu groups of rocks;(Berrange 1977, Morris and Bramley 1959).

(4) Makarapan Granite:(the riebeckite - aegirine leucogranite found in the Iwokrama Formation) (Carter, M.W. 1962, Berrange 1970, Barron 1962).

(5) Kanashen Adamellite:(probably an outlier of SSG surrounded by Kuyuwini Group rocks).

(6) Aminge Granite and Marudi Granodiorite: (small late plutons).

Basically, the granitoids vary in composition from potassic granites through granodiorites and even diorites, but they have been categorized into foliated auriferous (probably older types), and generally non-foliated, non-auriferous (younger types) by Barron (1970) based upon their occurrence in the northern greenstone terrain of Guyana. In the south, Berrange (1973, 1977) finds it more convenient to distinguish between a grey, autochthonous foliated biotite (± muscovite, hornblende, epidote) sodic granite and a pink, massive allocthonous biotite-muscovite ± (epidote) potassic granite. In southern Guyana where Berrange worked, the grey autochthonous granites are well represented in Southern Guyana Granite Complex, the Essequibo-Corentyne Granite Complex and the Kanashen Adamellite where they form the major types, while the pink potash-2-mica granites are clearly younger and of smaller extent. There are areas where the grey granitic rocks are seen to grade into leucocratic pink granite by an increase in the potash feldspar content. The pink granites on average seem to be related to late stage pegmatites and aplites as at the contact with the Kwitaro Group rocks. In the north, the apparently older auriferous granitoids are foliated, especially at their margins where the ferromagnesians are typically converted to chlorite and epidote. Most of the pink and grey granitoids of southern Guyana are non-auriferous, the notable exception being the allochthonous Marudi

Granodiorite, and to a lesser extent the Aminge Granite.

The apparent chronological relationship displayed by these granites can best be investigated by reference to the experiences of Holtrop (1969) in Surinam and Choubert (1974) in French Guiana. In Surinam, Holtrop described three sets of granites, which are chronologically and mineralogically distinct. His Granite 1 is assumed to be of basement origin, while his Granites 2 and 3 have been intruded in Paramaka (Barama-Mazaruni) times. Granite 2 can be classified from a massive granite 2D, 2E (sensu stricto) core, which passes into a foliated more basic margin of granodiorites, quartz-diorites referred to as Granites 2A, 2B, 2C. These granites, like Barron's (1970) early granites are auriferous and are associated with large anticlinal and domal structures. Granite 2 was apparently emplaced as a result of a Guyana pulse of the Trans-Amazonian tectono-thermal event in Barama-Lower Paramaka times when dominantly north-south, and northeast - southwest trends were established. After middle Paramaka-Barama times and during Cuyuni-Haimaraka-Rosebel-Armina times, and the emplacement of the auriferous Granite 2 and its affiliates in Guyana, a Surinam pulse of the tectonothermal event produced dominantly northwest-southeast structures, and Granite 3A-B was emplaced. Like Barron's later granites, the Granite 3A-B are associated with numerous pegmatites and aplites and they are rich in Sn, Nb, Ta, Be, Li, Mo and Bi. Granite 2 is essentially synkinemtatic, autochthonous to para-autochthonous,while Granite 3 is post-kinematic, and they are both probably formed by anatexis and granitization.

In French Guiana, Choubert (1974) defined 4 major types of granites. These are:

(1) Granites pre-guyanais or Granites primaires
(2) Granites guyanais secondaires or granites Guyanais
(3) Granites caraibes anciens
(4) Granites caraibes jeunes.

The granites guyanais primaires closely resemble the grey, autochthonous biotite granites of Berrange (1977), and are here suggested as direct correlatives. They represent the early granitisation phases in the basement in early Trans-Amazonian times which are dated at about 2600 Ma by Choubert and about 2400 Ma by Berrange (earliest K-Ar date, Snelling and McConnell (1969) given by the Makarapan Granite were 2595, but later found to be 2375 Ma (Berrange 1977), Essequibo-Corentyne Granite dated at 2375 Ma). The granites guyanais were thought to have been emplaced at 2200 Ma ago by Choubert, unlike the Granite 2 and auriferous granites of Surinam and Guyana respectively, which give ages of approximately 1800 Ma. This difference apart, the granites are similar in composition and occurrence.

The Granites Caraibes have been divided into a syntectonic early phase and a post-tectonic younger phase, which both essentially trend in a north-westerly direction and are similar to Holtrop's Granite 2, the younger granites of northern Guyana and the pink, allochtonous 2-mica granites of southern Guyana. However, it should be mentioned that some of Choubert's early Granites Caraibes resemble the Granite 2 and the auriferous granites of Surinam and Guyans respectively. The Granites Caraibes are thought to have been emplaced between 2000 and 1800 Ma ago, which corresponds to a similar age for the Granites 2 and 3 of Surinam, the allocthonous granites of southern Guyana and the 2 granite phases found in the north.

The early grey biotite granites of Guyana, Granite 1 of Surinam and the Granites guyanais primaires are accompanied by extensive migmatite zones, and augen gneisses, the latter occurring especially where it intrudes supracrustals such as the Kwitaro Group where the Kusad Augen Gneiss develops. These earlier granites were followed by another remobilization giving rise to paraautocthonous auriferous granites during the Guyana thermal episode, which was soon after followed by the late differentiates of the Surinam episode where essentially allocthonous forms were developed.

GLOBAL SETTING OF THE GUYANA ROCKS

Kroner (1977) identified four main tectonogenetic cycles in the Precambrian of Africa. These were:

(i)	The Limpopo-Liberian event	2700 ± 200 Ma
(ii)	The Eburnian event	2000 ± 200 Ma
(iii)	The Kibaran event	1100 ± 200 Ma
(iv)	The Pan-African event	600 ± 200 Ma

Each of these events is represented in the Guyana and West

African cratons to various extents, but the most pervasive is the 2000 Ma tectonothermal event, which is known as the Trans Amazonian Orogenic Cycle (Hurley et al 1967) in the Guyana Shield. The equivalent event at 2700 Ma is known as the Imatacan event in the Guiana shield, while the one at 1100 Ma is represented by the K-Mudku-Nickere tectonothermal event, which has left in its wake, a large band of cataclasites in southern Guyana and western Surinam. The Pan-African event is barely noticeable in the West African and Guyana Shields, but its presence has been reported nonetheless.

Even though the West African and Guyana shields were consolidated during the Eburnian-Trans Amazonian tectonothermal event, there are traces of an older nucleus such as in Sierra Leone - Liberia, or Imataca in Venezuela which must have experienced an event of tremendous antiquity (pre 3000 Ma), termed the Gurian by Bellizzia (1974) in Venezuela. On these basements were deposited the sediments and volcanics which were to be reworked by the 2800 Ma Liberian - Imatacan event. Crustal reworking evidenced by relatively high Sr 87/Sr 86 ratios, formed the Supamo Complex, and Liberian-Sierra Leone basements on which the Carichapo-Pastora, Barama-Mazaruni, and Birrimian supracustals were deposited. These later supracrustals, along with their basement were then intensely reworked by the Eburnian-Trans Amazonian orogenic cycle.

The pattern that evolves is that of a series of linear belts of high-grade metamorphites, which are connected, while forming the basement for the later supracrustals (Hurley et al 1973, 1976). Bard and Lemoine (1976) confirm the reworking hypothesis by documenting Liberian rocks in xenolithic relationship to Lower Birrimian rocks, while Berrange (1977) documents a similar relationship in the Kanuku Complex. Therefore, in the specific case of the West African and Guyana shields, the high-grade, mobile belts are typically areas of crustal reworking, such as described by Wynne-Edwards and Hassan (1970) for the North Atlantic continents.

The similarity of the lithologies on the West African and Guyana shields has been recognized for a long time (Hurley et al 1967, 1968, McConnell 1969). Recent accounts by Barbey (1975), Behrendt et al (1974), Hurley et al (1976), Gaudette et al (1978) have facilitated greater details in the chrono-lithologic classification while emphasizing the similarities. Table 28 summarizes these similarities, and highlighted the fact that the two shields were integral parts of a previously existing larger unit which was finally broken up in Mesozoic times.

Paleomagnetic evidence given by Piper (1973) would seemingly uphold the integrity of this large proto-shield, hence suggesting that the current distribution of high-grade and low-grade greenstone areas must be accounted for by vertical rather than lateral tectonics. This has been amply demonstrated by Westerman (1969) in northern Guyana, Berrange (1977), and by Spooner et al (1971) in southern Guyana, where steeply plunging structures, deduced motions from faulted surfaces and the dominance of lineation over foliation indicate a predominantly vertical transport direction.

Because of these facts, the prevailing calc-alkaline association of the high grade and greenstone areas (Dougan 1977, Singh 1966), must be attributed to natural characteristics of these lower Proterozoic-Archean areas, rather than conjure up plate tectonic models of continental margin association. As such, the tectonic setting is best viewed as due to vertical movements à la Annheuser (1975), Glikson (1976, 1978, et al 1973), Shackleton (1976), Kroner (1977), and Baer and Veizer (1978). The plate tectonic models of Windley and Bridgewater 1971, Windley (1976), Rutland (1973), Burke and Dewey (1973), Burke et al 1976, Sutton (1973, 1977), do not therefore, seem to be applicable in these areas for reconstructing pre-Pan African events.

CHAPTER SEVEN

METALLOGENIC CLASSIFICATION AND IDENTIFICATION OF TARGETS

The previous chapters described the lithostratigraphy, petrography and structural framework of Guyana. These descriptions were concerned particularly with the identification of broad geologic environments, which have direct correlatives in other parts of the world. The underlying assumption in the delineation of these environments is that the petrography, geochemistry and the tectonic setting of a given rock sequence are intimately connected to any mineralisation it may contain. This chapter first focuses on establishing these 'structural - metallogenic zones' (Bilibin, 1968) which Lafitte (1967), terms 'metallotects'. The second concern is then to identify the specific features which would help the explorationist to discover any available deposit. The chapter concludes with an assessment of exploration priorities, and the likely areas for the functionings of the geological survey and the parastatal mining corporation.

The classification in Table 29 is largely influenced by the works of Bilibin (1968), Shatalov (1961), Boyle (1976), and Pereira (1963). It emphasises the sequential evolution of orogenic belts, in terms of the prevailing magmas, sedimentation types and patterns, structural settings, and the associated mineralisations at each stage. Therefore, armed with such a characterization for mobile belts elsewhere, it then becomes a matter of classifying the lithostratigraphy of

Guyana accordingly. The next step is to isolate those peculiar features which are emphasized in the Guyanese rocks, and infer an endogenetic mineralization based on the existing local occurrences. Where these are not immediately known, inference is drawn from similar environments elsewhere.

The classification is divided into metallogenic provinces, metallogenic zones and ore districts. The bases for this division are relative size of area, and the level of generalisation of the features considered characteristic. The metallogenic province is used here to typify a specific stage of the sedimentation and evolution in the tectonic magmatic cycle. It corresponds to the seven environments identified in the previous chapter, these being the Kanuku Ancient Platform, the Barama-Mazaruni Greenstone Belt, the Kwitaro-Continental Supracrustals, ~~the~~ Burro-Burro and Kuyuwini Shelf Facies, Granitoid Rocks, Roraima Cratonic Sequences, and the Takatu Graben.

Metallogenic zones are then defined by isolating specific formations, which have signs of a particular mineralization type. Where a specific mineralization is not known to exist, the features which are conducive to the localization of certain elements are described, and the inference is made from the category of analagous areas, of some of the metals which should occur. The 'ore-districts' category attempts to identify the cations reported from specific areas. This category should ideally be defined by

TABLE 29

METALLOGENIC CLASSIFICATION OF GUYANA

	METALLOGENIC PROVINCE	METALLOGENIC ZONES - ORE BEARING BELTS AND METALLOGENIC REGIONS WHICH DETERMINE THE CHARACTER OF TYPICAL GROUPS OF ORE- BEARING REGIONS	ORE DISTRICT:- ORE BEARING FORMATIONS WHICH DETERMINE TYPICAL FEATURES OF THE INDIVIDUAL ORE BEARING DISTRICTS	ANALAGOUS AREAS ELSEWHERE, AND THEIR ASSOCIATED MINERALISATION
A	Kanuku Ancient Platform (Granulite and amphibolite facies of metamorphism)	1. Lenses of ultramafics (Appinitic Intrusive Suite). 2. Ferruginous quartzites (BIF).	1. Magnesite deposits at Badidiku Mt., Charwir River, Achwuib Mt. 2. Quartzitic magnetite-hematite of Tiger Hill, Wichibai, Kurad Mountain Kotauton Hill, Tup-Tup Tyal Hills.	1. Cr in Fiskenasset, W. Greenland, Ni, Cu at Selebi-Pikwe in Botswana. 2. Itabarites of Venezuela; Superior type deposits of Minnesota, Quebec and Labrador; BIF of the Limpopo belt, and Southern India.
B	Barama-Mazaruni Greenstone Belt (sequence of slightly metamorphosed (ultra) basic-intermediate and acid volcanics with varying amounts of greywacke and chemical sediments)	1. Lowermost spilitic basic-(ultra basic) rocks of calc-alkaline affinity, with minor tuffs, chert, and greywacke e.g. Lower Tenapu fm., Aravai fm., and unit 1 of Gibbs(1977) at Barsmita. Highly sheared rocks. Carbonisation prevalent as at Mara-Mara.	1. Ni at Five Stars in Baramita mafic metavolcanics; Ni-Cu at Wariri? Possibly Ni-Cu at Kauramembu. Also at Itaki Hills. 2. (a) Bedded manganese deposits of Matthews Ridge, Pipiani, Tassawini, and Saxacalli.	1. Ni-Cu in Abitibi Belt near Cochrane Ni-Cu in Thompson-Wabowden belt in Manitoba. Ni-Cu sulfides at Sudbury, Ontario. 2. Mn- in Karadzhal deposit of Central Kazakhstan (USSR).

B	2. Marine terrigenous volcanic sediments (Cherts and phyllitic meta tuffs) typified by the Matthews Ridge Formation.	(b) Ferruginous quartzites, near Arakaka	3. Abitibi belt of Canada; Noranda type stratabound sulfides; Kidd Creek massive and disseminated sulfides. Rio Tinto, Spain Also similar to the stratabound-metamorphic reef gold deposit at Homestake, South Dakota.
	3. Differentiated volcanics, hypabassals and intrusives with extensive greywacke intercalations. Terrigenous sediments increase in upper part of sequence. Represented by the Western and Central Cuyuni formations, the Puruni formation, the Arakaka formation, and the Haimarka formation. - Structural control of mineralisation paramount. - Extensive alteration with pyritization, chloritization, carbonitization, sericitization and silicification being very evident. - Basically auriferous, especially when associated with intrusive granitoids. - Stratiform dilatant zones infilled with quartz are characteristic.	3.(a) Pyritic Au-Cu-Zn sulphides as at Groete Creek. (Massive strata bound. Highly sheared). (b) Pyritic Au-Cu-Zn sulphides as at Aremu (Large amount of carbonaceous and graphitic rocks present). (c) Pyritic Au veins at Peter's Mine, Area 33, with significant Cu,Zn sulphide association neighbouring Kazoom Creek, Usgus Creek, Mara-Mara Creek, and Million Mountain area. Significant alteration and shearing. (d) Pyritic Au-Cu-Zn-Co-Ni sulphides in highly carbonaceous arenites at Waigmu and Waikuri area. (e) Pyritic Au-Cu-Zn (Mo) sulphides in sheared Cuyuni formation rocks at Aurora. (f) Pyritic Au-Cu-Zn-Ag sulphides with accessory pyrrhotite at Aranka (Highly fractured, and silicified).	4. (a) Beidelman Bay Cu-Mo porphyries on the south shore of Sturgeon Lake, Ontario. (b) Mo porphyries of northern Finland.
	4. Andesitic magma with development of quartz albite porphyries, quartz diorites, granite and granodiorite porphyries.		

		Extensive fracturing, and hydrothermal alteration.	(g) Pyritic Au-Cu anomaly with accessory pyrrhotite and arsenopyrite at Tassawini. Highly sheared and altered. (h) Pyritic Au quartz veins with accessory chalcopyrite, and molybdenite at Honey Camp, and El Dorado. 4.(a) Mo-Cu-Au mineralisation with intense pyritization, and other hydrothermal effects principally sericitic and propylitic as at Eagle Mountain. Cassiterite and scheelite are common associates. Accessory Cr, Ni, Zn, Ag, as at Omai. (b) Mo, Au quartz veins in extensive shear zone with accessory arsenopyrite as at Yakishuru Hill, and Ianna.	
C	Kwitaro Continental Supracrustals (meta-pelite and meta-arenites)	1. Continental meta pelites, and meta-arenites with variable amounts of calcareous horizons. Little volcanic affiliates (principally felsic).	1. (a) Auriferous quartz veins noted at Wakadanawa, and Marudi Mt. At the latter, extensive pyrite and silicification developed.	1(a) General Kwitaro environment is similar to the copper bearing regions of the

	Amphibolite grade metamorphism characteristic, with variable degrees of metamorphism. Quartzite is invariably abundant. Type formations are Dampau, Lumidwau, Marudi, Osonoque and Wakadonawa. These are greatly migmatised at their contacts with the granitoid intrusives. Pegmatites and aplites well developed.	Associated minerals are pyrrhotite, calcite, arsenopyrite and chalcopyrite. (b) Low grade ferruginous quartzites especially in Marudi formation.	Dzhezkazgan, USSR; and of Zambia-Zaire. (b) Similarities to the Sullivan lead-zinc sulphides in the Aldridge formation of the Belt-Purcell Group. (c) Uranium possibilities of the Rossing type in South Africa, and Charlebois Lake in Saskatchewan.
D Burro-Burro and Kuyuwini Shelf Facies	1. Acid-intermediate volcanism, with small amounts of intercalated shallow water sediments. Associated hypabyssals and deeper plutons subsequently intrude and deform volcano-sedimentary succession. Greenschist grade metamorphism. Highly fractured. Pervasive hydrothermal activity. The Muruwa formation is essentially orthoquartzitic. The volcanics are represented by the Iwokrama, Deadman Ridge, Kamoa River, Sipu River, and Water Falls formations. The subvolcanics	1. No known mineralisation, but molybdenite disseminations occur in the related Surumu Formation of Brazil.	1. (a) Similar environments recorded in the silver-cobalt-nickel-bismuth-arsenic-(copper) uranium) mineralisation of the Great Bear Lake Region. (b) Lead-zinc barite-witherite deposits of the Meggen area in W. Germany. (c) Muruwa formation is very similar to the uraniferons Texas Plain environment. (d) Carbonatite

		and intrusives are represented by granites, alaskites, alkaline granites (Iwokrama), granophyres. Alkaline (possibly carbonatite) complex at Muri Mt.		complexes at Jacupiranga (Brazil) and Palabora in South Africa.
E	Granitoid Rocks	1. Granitic to Diorite intrusions, associated pegmatites, and aplites.	1. (a) Magmatically derived iron deposits at Putareng, Enachu, and Upper Pomeroon. (b) Muscovite near Kartabu Point, Karawatta Creek in the north and at Crabwood Creek, Sand Creek, Wichabai, and Surab River, Parabara Savanna and Isherton in the South. (c) Columbite, tantalite associated with the Morabisi Granite, and some of the Bartica Granites.	1. (a) Iron Springs, Utah, Magnitnaya, USSR. (b) Numerous occurrences in the Brazilian Shield e.g. Ceara and the Precambrian of Argentina at San Luis-Cordoba, Valle-Fertil and Salta. (c) Bernic Lake, Manitoba, Brazilian and Argentinian examples mentioned in (b) above, as well as the large beryllium mine in the Black Hills, South Dakota.

F	Roraima Cratonic Sequences	1. Flat-lying, unmetamosphosed rudites, arenites and pelites with minor jasperoid (devitrified fine grained felsic tuffs) horizons. Two massive dolerite sills intrude the group.	1. Diamondiferous conglomeratic horizons thought to be the source of most of the alluvial diamonds.	1. Uraniferous basal conglomerates at Elliot Lake, Canada; Witwatersrand; South Africa; and Jacobina, Brazil; In the latter two, the gold component is significant, as it is at Tarkwa, Ghana.
G	Takatu Graben(infilled with sediments and thick basaltic volcanics).	Thick sequence of mid-Jurassic tholeiite sheets (the Apoteri Volcanic Formation) underlies a predominantly pelitic upper layer. (Takatu formation). The pelites characteristically contain a high calcareous content, and become arenaceous in parts.	1. Isolated reports of chalcopyrite, and pyrite in the upper sedimentary strata, and in the Apoteri volcanics at Toucan Hills.	1. (a) Copper in the Coppermine River Group in N.W. Canada. (b) Copper in the Keweenawan basalts in Michigan. (c) Lead-zinc deposits of Sullivan type, British Columbia.

actual mineral types, but this is extremely difficult in Guyana because a number of the locations refer to anomalous geochemical occurrences, while there is relatively little documentation of economic mineral types, as a catch-all "opaques", or "accessory sulphides" are type descriptions in most petrologic accounts.

THE KANUKU ANCIENT PLATFORM

The Kanuku Ancient Platform is characterized by upper amphibolite and granulite grade metamorphism, with a great degree of structural complexity caused by different periods of tectonomorphic events. If the original sedimentary and igneous rocks had contained many mineral concentrations, then these events would, in large measure, destroy or disseminate the ore deposits. This fact is largely responsible for the paucity of ore deposits in such high metomarphic grade areas.

Notable exceptions are some banded iron formations in the Limpopo belt, the Beartooth Mountains, U.S.A., the Imataca itabarites in Venezuela, and in Southern India. The occurrences in Guyana's Kanuku terrain are relatively small, discontinuous magnetite-hematite-ferruginous quartzite bodies with limited vertical dimensions (Barron, 1960; Berrangé, 1977, Gross, 1962). Gross (op cit) concluded that the deposits were of insignificant size and hence could not be considered as potential sources of iron ore. This conclusion was based on magnetic responses and field checks.

Associated with large xenoliths of ultramafics (the Appinitic Intrusive Suite) are occurrences of residual magnesite (Barron 1961, 1962; Walrond, 1975; Singh, 1976). The locations are mentioned in Table 29 , and in some cases as at Badidiku Mountain especially in the river sections, a clear transition can be seen from amphibolites (after ultramafics) at the base to relatively pure magnesite (MgO 46.1%, CaO 2.3%, SiO 3.12%, LOI, 50.95%) at the top. The bodies are typically lenticular and discontinuous though the author was able to trace one over approximately 400 M. These deposits would only be of local significance, since their location, variable grade and small sizes would mitigate against any economic venture at this stage. However, when total magnetic coverage of this part of the country does become available, the picture can possibly change, since Southern Guyana is still a relatively unknown entity, while the possible association of chromium, nickel and copper within these ultramafic lenses must be taken into account as exemplified by the occurrences at Fiskenaesset, West Greenland and Selebi-Pikwe in Botswanna.

The Kanuku rocks are relatively deficient in volatiles and only in marginal areas are there signs of greater mobile components in the pegmatites and aplites that exist. Coupled with the actual paucity of these later differentiates, then the Kanuku might not be a likely place to find lithium, beryllium, rare earths and uranium. However, one should always consider these possibilities whenever any future investigation is planned for the area. Few significant amounts of alluvial gold were reported from the area, and are not likely to be of much interest.

THE BARAMA-MAZARUNI GREENSTONE BELT

This metallogenic province is characterized by a sequence of slightly metamorphosed basic, intermediate and acid chemical sediments. Typically, the basic volcanics, which may bave ultrabasic layers in parts, occupy the lowest level in the sequence. This is followed up the sequence by more differentiated calc-alkaline acid volcanic strata. The sedimentation patterns involve a transition from primarily siliceous volcanic emanations to increasing amounts of tuffs, finally culminating in a predominantly greywacke sequence at the upper levels. The volcanics and sediments characteristically interdigitate, especially in the upper sections. Gibbs (1978), has shown that in the Barama Group of 8 kms. of volcanics and sediments, the lower 5 kms. is essentially volcanic.

The map of mineral occurrence (Fig. 8) shows an overwhelming concentration of gold throughout this metallogenic zone. More than 96% of all the listed occurrences essentially represent alluvial-eluvial gold operations which are either currently functional or had been worked. The remaining 4% represents lode mining endeavours which are virtually nonexistent at the current time. It was the preoccupation with gold that led to the first set of mapping exercises in Guyana. That preoccupation has unfortunately led to a virtual disregard for base metal occurrences, especially with regard to the indicators of the latters' potential presence. Prior to the 1960's, the Guyana and West African shields were thought to be deficient in base metals, which some advocates consider to have been leached out. However, aeromagnetic and aeroelectromagnetic (EM) surveys in parts of northern Guyana in 1962 and 1971 revealed that there were some significant aeromagnetic anomalies, and these were followed up quite vigorously, especially in the 1963 to 1970 period.

This follow-up work was essentially composed of geochemical sampling, largely on soil and stream sediments and over localized area indicated by the aeromagnetic anomaly. It is extremely unfortunate that the quality of geological reporting, especially about descriptions of the various lithologies was not as thorough as it could have been. Particularly lacking were descriptions of associated opaque minerals, and the chemistry of whatever rock samples were collected. As will be explained later, significant opportunities for assessing the potential of the areas were lost as a result.

Basically, if conventional geochemical sampling backed up by colorimetric tests on a limited range of elements (Cu, Ni, Zn, As, Co, Pb, Cr), atomic absorption spectroscopy (Cu, Ni, Zn), and spectrographic analysis (on a wider range of elements), do not prove the presence of an anomaly, the area is virtually written off. Of particular significance is the relegation of apparent or actual 'graphitic' or 'carbonaceous' horizons to areas of lesser priority. In Punwasee's (1970) appraisal of the course of geochemistry in Guyana from 1962 to 1968, he refers several times to cases where EM conductors were not followed up because they were obviously conducting, carbonaceous, non-mineralized environments, especially if a proximal geochemical anamalous zone was not detected. One should recognize that carbonaceous, graphitic horizons are characteristically reducing environments, and if they occur in any region proximal to volcanic or fumarolic emissions, the likelihood of a concentration of basemetals increases significantly. The opportunity must always be sought to follow the lead of such environments as they are more than likely to lead to an ore deposit, if in fact there is one. There are many cases where immediate geochemical responses are not fruitful, but combined with a follow up of such horizons, deposits can be found.

The lowermost mafic-metavolcanic rocks of the Barama-Mazaruni belt as represented by the Lower Tenapu Formation, Unit 1 of Baramita and possibly the Arawai formation, have been spatially related to anomalous nickel values at Five Stars in Baramita. At Kauramembu (Wanamu-Blue Mountain area) drilling has indicated a lateritic horizon which contains about 10 - 20 million tons of nickel ore averaging about 1% Ni (Vallance, 1969), overlying a serpentinite. The deposit was associated with soil geochemical anomalies of nickel, chromium and cobalt. Stream sediment geochemistry on the drainage network servicing the Tenapu Formation gave anomalous levels of chromium, and cobalt, coupled with a non-coincident anomaly of nickel, copper and zinc, as in the Monkey Falls and Eclipse Falls area (Panwasee, 1970).

The northeastern sector of the Omai area (Guardia's, 1967 anomaly area C) shows anomalous Ni-Cr-values. It is also interesting that north east of this area in the Mariaba-Appaparu-Kushekatra district on the Demerara River anomalous Cu-Cr-Ni values are also found (Sampson 1967). This area is covered by the Tertiary White Sand Series, which probably overlies meta ultrabasic rocks. The isolated anorthosite body to the north west certainly increases the possibility that differentiated ultrabasics are present. The association of nickel-copper sulphides is well known in the Cochrane area of the Abitibi Belt, as well as the famous deposits at Sudbury, Ontario and Thompson, Manitoba. In the long term, the subsurface geology of this area must be established. A few drill holes on either side of the Bartica Potaro Road between the Kaburi and Paraweka Rivers should prove to be quite interesting.

At Matthews Ridge, Pipiani, Tassawini and Saxacalli, predominantly manganiferous phyllites, slates and cherts have been weathered, and leached of silica to produce relatively high grade supergene manganese deposits. Basically, a fragmentary, non-bedded ore caps the hills, and this passes imperceptibly to lower levels where bedded, lower-grade ores are present. There are five ore types, of which the bedded residual ore is the most important. The other four are variants of different concretionary forms, and a lateritic pisolite.

The manganese deposits occur in two sedimentary basins, a northern Barima Basin, and a southern Barama Basin which are separated by the positive Anabisi-Haiari Axis, which incidentally is more ferruginous. The immediate implication of this is that north and south of the Anabisi-Haiari axis, are present deeper, possibly more anoxygenic environments, hence the more likely environments for base metal deposition are approached. This aspect will be developed more fully later. The Barima basin has a Matthews Ridge Formation type sedimentation pattern of cyclical, symmetric slate - chert - manganese - chert - slate succession with iron subordinate to copper. The Barama basin, characterized by the Pipiani type stratigraphy has a greater development of cherts, as two massive chert layers, the upper carbonaceous as at Tassawini, the lower ferruginous, underlie the manganese horizon (Fernandes, 1963, Westerman, 1969).

Manganese was mined from 1960 to 1968 by the North West Guyana Mining Company Ltd. a subsidary of African Manganese Ltd. of the Union Carbide Group. The grade of the ore shipped declined from its 1960 levels of 50-55%, to approximately 35 to 40% by the end of operations. The decreasing tenor of the ore coupled with its increasing clay content, and relatively soft market situations forced the company to cease operations, even without bringing into production the deposit located at Pipiani, 25 miles to the east-southeast.

As of 1968, the reserves at Pipiani and Matthews Ridge were as follows:

Pipiani:	Minimum	634,155 tons at 42.0% Mn
	Maximum	825,852 tons at 42.5% Mn
North Prospect:	Minimum	40,830 tons at 36.0% Mn
	Maximum	60,600 tons at 39.0% Mn
Matthews Ridge:	Minimum	318,059 tons at 37.0% Mn
Total:	Minimum	993,044 tons at 40.0% Mn
	Maximum	1,204,511 tons at 40.7% Mn

Source: Dewit Smith and Company Inc. (1969)

The reserves at Pipiani may be understated because of the structural assumptions made about the continuity of the ore body. The company assumed a synclinal structure, which was later disproved by Ghansam (1970), hence there was the possibility of continuity at depth. However, the nature of the deposits in terms of their grade would probably have not caused very significant increases in mineable ore, since the company's projections were already in the lower grade, higher clay content, bedded ore as opposed to the silica-leached upper detritals.

The plant and equipment have fallen into disrepair, and any new manganese venture would have to be completely capitalized. Though the current market for manganese is significantly better than it was in 1968 when manganese was valued at U.S. $9 to U.S. $14 per ton c.i.f., the required capital outlay exceeds the current value of the deposit. (Note that in 1960, the company had made an outlay of G $20M). The current mines will therefore have to remain closed except if it is connected with an integrated ferro-manganese operation, if enough resources of iron are to be found. The local interest in manganese for battery production is well advised to continue importing manganese as this element constitutes less than 1.5% of battery raw-materials requirements, while coupled with the smallness of the Caricom market (just under G $4 million in total battery sales, hence a negligible value input of manganese), (Robertson 1976 personal communication), the prospects for an economic manganese operation are very poor.

For the next sequence to be described the contributions are legion, but the reader will be referred specifically to McDonald (1968), Barron (1969), Punwassee (1970), who have summarised the actual descriptions. Only when a specific contribution needs to be cited will the original author be identified.

Going to the upper part of the greenstone sequence, the rocks represented by abundant meta-greywackes with intercalations of differentiated intermediate to acid meta volcanics are well represented. These rocks are spatially restricted to the north central portion of Guyana where they are represented by the Central and Western Cuyuni Formations, the Puruni Formation, and the Haimarka Formation. Like the area to the north which hosted numerous alluvial gold showings, this area is also well endowed with gold, which was used as pathfinders to base metal occurrences (Punwassee, 1970).

In Table 29, it becomes extremely apparent that the deposits listed under this metallogenic zone share some common features, which are typical of specific ore associations in the greenstone belts of the world. In particular, the association of iron - copper - zinc sulphides is characteristic of this environment. Typically, the iron occurs as pyrite which is ubiquitous in the quartz veins, which are typically auriferous.

The next significant feature is the pervasive presence of shearing, and the intensity of the hydrothermal alteration which the host rock suffers. In all of the deposits listed in the table, either one or a combination of carbonitization, sericitization, chloritization, and silicification is present. The large amount of gold which these belts carry is invariably spatially related to intrusive granitoids, which Bilibin (1968) detected were normally associated in structurally defined shear zones.

Variable amounts of silver are always present, and in some deposits especially in the Arakaka, Tassawini, Ianna area, it substitutes isomorphically for the gold thus reducing the bullion value of the latter. An interesting relationship is displayed in the Barama group where going south from Arakaka to Ianna, the fineness of the gold decreases from 800 to 200. This reflects increasing amounts of copper and silver as the more mafic members are traversed.

The amount of zinc is variable, and often times is not very significant. Similarly, as is so characteristic of Precambrian terrains, lead is not very abundant, but it does occur at some locations.

Basically, two mineral association types are identified. The Fe-Cu-Zn-Au (Ag) association, which was described above, and the Fe, Au-Mo, Au (Ag,Cr,Co) associations are recognized. The former is restricted to the Cuyuni and Puruni areas, while the latter is found in the north at Yakishuri and Ianna area, and the southern part of the Mazaruni Group rocks in the Kaburi - Potaro area. The copper-molbydenum disseminations are normally related to high level granitoid intrusives and porphyries (Irasi,1976), but the source of the Cr, Ni etc. is often times enigmatic since basics - ultrabasics may not be immediately evident. Boyle (1976) describes similar porphyry associations in Canada with anomalous Cr, and he suggests that the porphyries may have been one of the sources of these metals, though it is far from being proven.

The possibility of discovering economic concentrations of these massive and disseminated sulphides are best viewed against those features which appear common to deposits of this kind as defined by Sangster (1972), Hutchinson (1973), Boyle (1976), Stanton (1972), Walker et al (1975).

The deposits generally have a stratiform aspect, though still showing some level of discordance to their enclosing rocks. They are therefore considered to be strata-bound, not unlike the description Hamilton (1968) gave for the

Groete Creek pyritic Au-Cu-Zn (Ag) deposit. The strata-bound aspect is well represented at Flin Flon, Manitoba, Kidd Creek, Ontario and Noranda, Quebec. These ores are spatially related to tuffaceous sediments, and are invariably restricted to the felsic-intermediate fractions of a volcanic cycle. Because of their proximity to volcanic centres, they can be sought for by identifying the agglomerates, coarse tuffs, and subvolcanic acidic flows which are all signs of proximal volcanic centres. In this regard, the coarse breccias, and tuffs identified in the vicinity of Area 33 north of Peter's Mine become significant.

Most of the deposits are associated with exhalites, cherts, iron formation etc., and usually display significant degrees of alteration especially in the footwall areas. In the Precambrian massive sulfides, the hangingwall is relatively unaltered, while the stringer bearing footwall is silicified, sericitized, chloritized or/and carbonitized. All of the occurrences in this metallogenic zone listed in the table have these distinct alteration patterns. In this regard, it is worthwhile for one to remember that chloritisation and sericitisation are desilication reactions, with the host rock becoming depleted in Si, K, and Na, while becoming enriched in Fe, Mg, and S (Roberts 1966; Boyle 1976). In particular Mg metasomatism is very prevalent, and always increases as one approaches the footwall stringer ore zone. This emphasizes the need for major and trace element analysis in geochemical analysis.

Most of the deposits are zoned, with the upper massive horizon being typified by pyrite-sphalerite followed at lower levels by chalcopyrite-galena, which in turn passes to a lower stringer ore zone of pyrrhotite-chalcopyrite. Hamilton (1968) found a zoning as follows in Groete Creek:

Pyrite
Pyrite-bornite
Chalcopyrite-pyrrhotite-pyrite
Pyrite-pyrrhotite

It would certainly be interesting to see what succeeds the last zone at Groete Creek, as it is not uncommon for a complete chalcopyrite-pyrrhotite association in the stringer zones.

Finally, the deposits typically occur in clusters, with a preferred alignment to local linears, as evidenced at Noranda where, the Old Waite, East Waite and Lake Dufault deposits are aligned along a north-easterly trending fault.

With this latter concern in mind, the magnetic map of Guyana is presented in Figure 9, and attention is called to the very pronounced north easterly and northwesterly trending lineaments. The known base metal occurrences are presented in Figure 8, and the straight alignment of the highly mineralized Groete Creek, Wariri, Aremu, and Peter's Mine must be observed. It was postulated in Chapter 6 that the Supenaam Lineament which was emphasized by late fracture-filling dolerite dykes, was a deep, pervasive structure which is directly related to the mineralisations noted at these four locations.

Figure 8

MAP OF MINERALISATION LOCALITIES

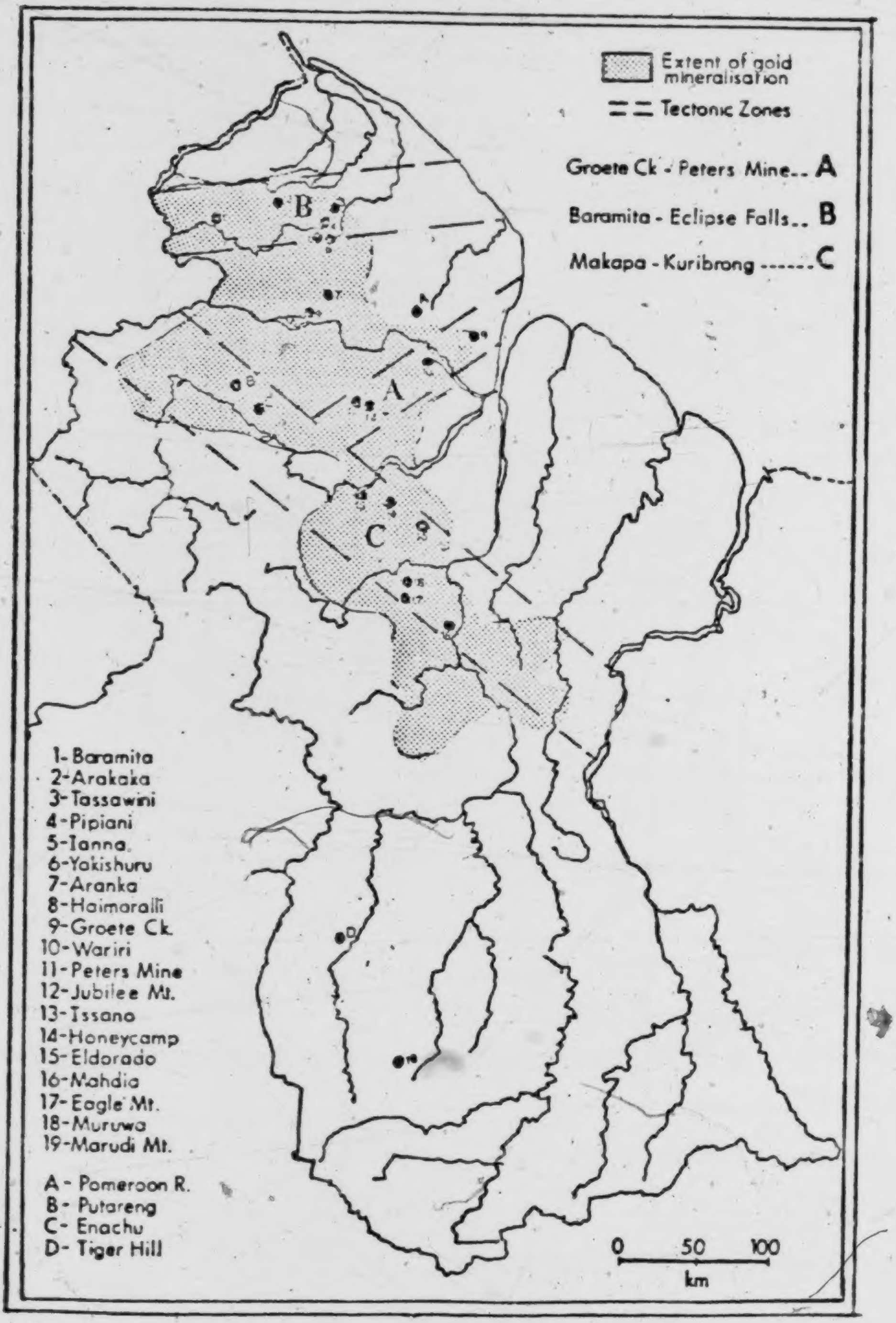
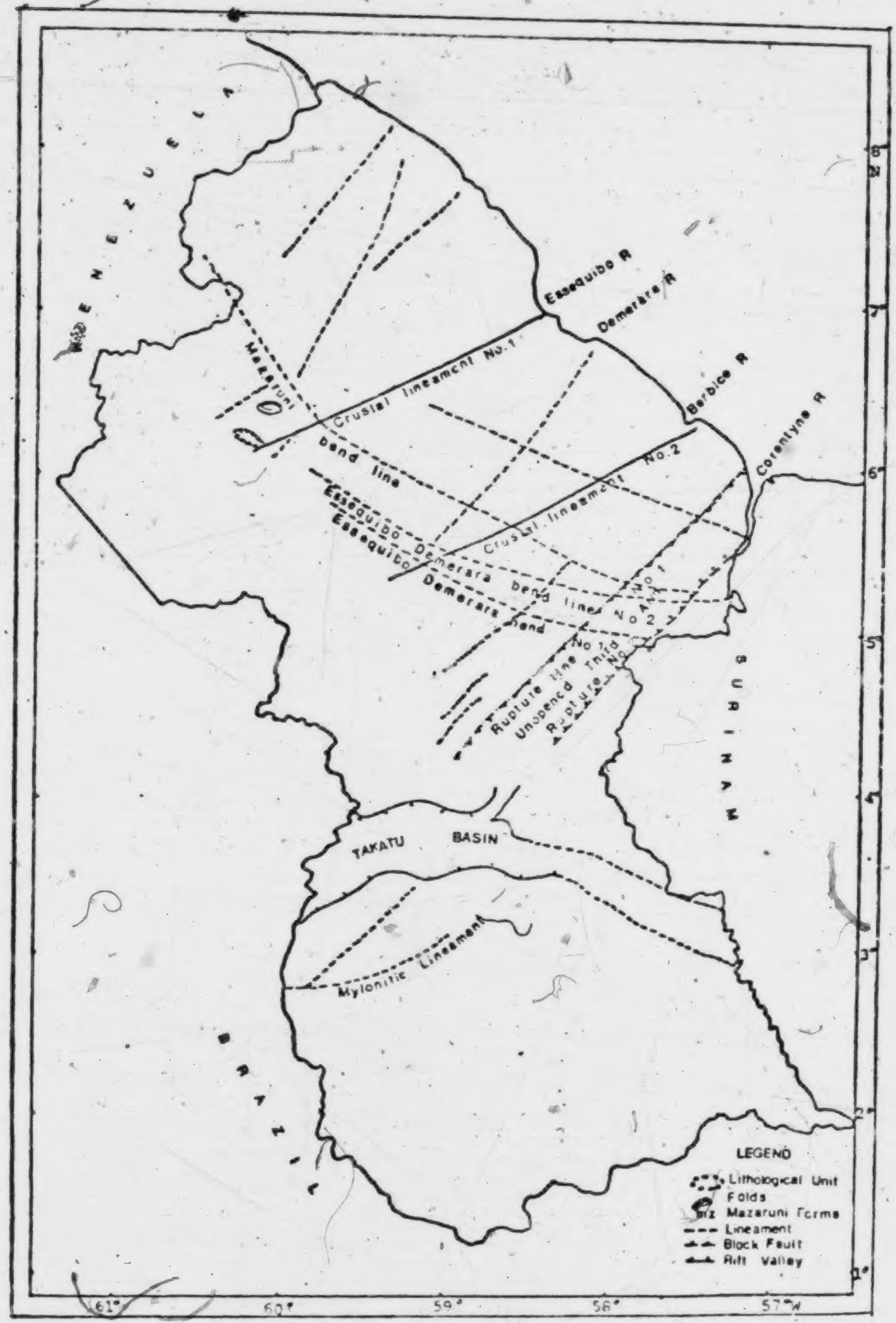

Extent of gold mineralisation
Tectonic Zones
Groete Ck - Peters Mine.. A
Baramita - Eclipse Falls.. B
Makapa - Kuribrong ------C
A
B
C
1-Baramita
2-Arakaka
3-Tassawini
4-Pipiani
5-Ianna
6-Yakishuru
7-Aranka
8-Haimaralli
9-Groete Ck.
10-Wariri
11-Peters Mine
12-Jubilee Mt.
13-Issano
14-Honeycamp
15-Eldorado
16-Mahdia
17-Eagle Mt.
18-Muruwa
19-Marudi Mt.
A - Pomeroon R.
B - Putareng
C - Enachu
D - Tiger Hill
0
50
100
km

FIGURE 9

Interpretation of Magnetic Data


VENEZUELA
Mazaruni
Essequibo R
Demerara R
Berbice R
Corentyne R
Crustal lineament No.1
bend line
Crustal lineament No.2
Essequibo Demerara bend line No 1
Essequibo Demerara bend line No 2
Rupture line No 1
Unopened Third Arm
Rupture No 2
SURINAM
TAKATU BASIN
Mylonitic Lineament
BRAZIL
LEGEND
Lithological Unit
Folds
Mazaruni Forma
Lineament
Block Fault
Rift Valley
8°N
7°
6°
5°
4°
3°
2°
1°
61°
60°
59°
58°
57°W

It is also to be noted that the beryllium-tantalum mineralized Morabisi granite is emplaced in another zone identified by the Essequibo Demerara Bend Line, along which a number of earlier granites were intruded. In this zone, one must identify the essentially magmatically related iron deposits at Putareng-Enachu, and the molybdenum, copper and gold of the acidic hypabyssals, and deeper intrusives of Tikwah, Honey Camp, Itaki Hills, and Omai. This zone corresponds roughly to the area of influence of the Makapa-Kuribrong Shear zone mentioned in Chapter 6.

It is conceivable that these major lineaments represent deep fractures which have activated at different times and along which volcanic and/or fumarolic emanations must have occurred. When these emanations encounter reducing environments, sulphides are deposited. Subsequent reactions on the host rocks causes intense hydrothermal alterations. The fact that fumarolic emanations would leave a deposit of chemical sediments, cherts etc., in its wake implies that cherty horizons should be followed as much as possible, since they could conceivably lead to the desired anoxygenic environments which are typically found in deeper waters. Fernandes' (1963) findings which show that going north from Kaburi to the Cuyuni River, there is an increase in the thickness of the greywacke sedimentary pile by over 2800 km (i.e. 300km at Kaburi River to 3100km in Cuyuni River), would possibly infer that the basin was deepest as one approached the Cuyuni, hence the plethora of deposits in the general Puruni area may not be coincidental.

If in fact the ruputure lines of Hood and Tyl's (1973) magnetic interpretation are representative of an unopened third arm of the Takatu Rift Valley, then the presence of the isolated anorthosites, and spatially related mafic-ultramafic rocks which were giving the high Cr-Ni geochemical values north east of Omai, take on added significance. A drill hole in the location mentioned above is certainly an interesting prospect, as the possibility of a layered intrusive must not be discounted.

Groete Creek is one of the best documented base metal deposits in Guyana, and indeed it may be the 'most likely to succeed' of the deposits considered here. Hamilton (1968) indicated that the reserves of the deposit which has a proven strike length of 1525 m, and which pitches for 410 m, while having a mineralized width of 10 m at 0.6% Cu, and 245 m at 0.2% Cu are:-

16,875,000 tons at 0.6% Cu
843,750 ounces of Au
Average grade of Au = 0.05 oz./ton.
112,500,000 tons at 0.2% Cu

Simply using the higher-grade copper portion and its contained gold, the gross deposit value not allowing for a recovery factor nor a dilution factor, nor recovery of any copper is approximately U.S. $127 million assuming a gold price of U.S. $150/oz. With a more realistic price of U.S. $200/oz., then the value of the gold alone is U.S. $168 million. This is extremely attractive, and becomes even more so when one realizes that the south west and eastern extensions of the deposit were not drilled out. Knowing how extensive these horizons can be, this prospect is the most important one in Guyana at the moment, and should be the first preoccupation of the proposed mining corporation. Its initial task would be to test the lateral extensions and possible depth of the body, and then to proceed from these with mobilising capital, if it considers it necessary. It would be premature at this stage to give projected cost figures as this will depend on deposit characteristics, and production schedule.

The molybdenum occurrence at Eagle Mountain is the most interesting of the second group of deposits and unlike the case of the Groete Creek deposit, its dimensions are not as well known. Descriptions by Anaconda Mining Company which carried out exploration work in 1948, indicate that there was up to 28 metres of molybdenum mineralisation from 0.103% to 0.14% Mo. Later work by Inasi (1976) speculated as to the continuation of the southern extension of the mineralized body as far as the Konawaruk River. Inasi is of the opinion that combined with more significant gold values than presently indicated, the deposit could become viable.

Gold still continues to be a major source of interest in Guyana and appended to this thesis as Appendix 14, is a list of the best gold prospects as prepared by the Geological Surveys Department. This list is slightly modified from the original text.

As observed in the report by Alexander (1975), the eluvial-alluvial operations can be carried out using Guyanese expertise, while the hard rock venture would probably require expatriate consultants, and some external funding. Some of these deposits, could form the basis for the mining co-operatives discussed in Chapter 3. Ideally, the incorporation of professionals with these ventures could lead to some rather meaningful results. Initial investigation of the alluvial-eluvial deposits can be made rather labour intensive, while stressing the use of already skilled miners. When the deposit reaches the development stage, then the government acting on the recommendation of its mine evaluators (should be mining engineer contracted to do the job), could sponsor loans at the local banks on behalf of the co-operative.

The co-operative is of course free to enter any agreement with the public mining corportion or any other legal entity to carry out any phase of its operations. Secondly, government's approval of any loan should probably be accompanied by the condition that the co-operative enter into some agreement with the public mining corporation which will oversee the government's interest. Phase out provisions for the involvement of the public sector should also be incorporated, especially after the loan has been repaid, and the co-operative has established the ability to run the operations independently. The public corporation should probably adopt the role of consultants, and the co-operative's accounts should reflect the payments to this body as consultant fees. This arrangement would free the public corporation from the day to day operations of the enterprise, while giving enterprise and skills a chance to develop.

KWITARO CONTINENTAL SUPRACRUSTALS

The Kwitaro group as shown in Table 29 is represented by an admixture of meta-pelites and meta-arerites with intercalations of felsic volcanics. Several manganiferous and ferruginous horizons have been identified but they were all reported to be of very poor grades (Berrangé 1977).

Several reports of gold have been made particularly in the Wakadanawa and Marudi Formations. In particular, the latter formation hosts an interesting gold deposit, which is the number one lode-gold prospect in Guyana as seen from Appendix 14 . This gold seems spatially related to the late Marudi granodiorite intrusive, and is contained within a steeply dipping mineralised set of parallel veins in a silicified zone of over 45 m. Like similar occurrences in Northern Guyana it is highly altered and contains extensive pyrite, with accessory calcite, ankerite, sericite, arsenopyrite, pyrrhotite and chalcopyrite.

Like all the recent investigators of this deposit, this author strongly recommends work at Marudi mountain. The deposit has been defined to an extent which requires relatively expensive late stage exploration efforts (primarily drilling). Given gold prices of approximately U.S. $235 (at the time of writing) the deposit is extremely attractive. It should come directly under the responsibility of the Mining Corporation. Because there is a tremendous amount of basic geologic, and geochemical work to be done in the Marudi Formation and the entire southern Guyana area, it is recommended that the Geological Survey initiates its Southern Guyana work by concentrating on the Marudi Formation starting with the Marudi Mountain area.

A joint project is visualized between the Corporation and the Geological Survey in the intial years; the corporation with the drilling and the geological surveys with the geology-geochemistry-ground geophysics. The corporation's future participation will depend on results, while the GS. can continue its work in Southern Guyana, even if a decision is not made to go ahead at Marudi Mountain.

The Kwitaro environment appears similar to the copper-bearing regions of Dzhezkazgan predominantly metapelitic, meta-arentic horizons which form host to economic copper deposits. Similarly one can envisage similarities to the predominantly lead-zinc Sullivan deposits of British Columbia. This occurrence has been demonstrated to be connected with exhalative emanations, and the presence of felsic flows and tuffs in the Kwitaro perhaps reinforces the analogy. More structural information is definitely required especially with regard to the identification of deep seated faulted surfaces which must have acted as conduits for mineralising fluids. An overall strategy would be reconnaisance stream geochemistry for Cu, Co, Se, Pb-Zn, Ag, Au, As, combined with detailed geologic mapping in areas of interest.

The metamorphic grade of the Kwitaro Group is essentially of the amphibolitic facies. Numerous syn-and post-tectonic granites, their related pegmatites and aplites have been documented in the Dampau and Marudi Formations especially near the contact with the batholithic South Savanna Granite. These pegmatites are known to carry large books of mica (Barron 1965, Berrangé 1977), and possibly a high component of volatiles. These veins and pegmatites should be investigated for Rossing-type uranium deposits, such as those occurring in Charlebois Lake, Saskatchewan.

In this regard one must remember that the Kwitaro supracrustals were primarily derived from the underlying migmatites and granulites of the Kanuku surface, hence there is a possibility of uranium concentrations in the Kwitaro sediments. The uraniferous resistates (euxenite, monazite) found in the para-autochtonons South Savanna Granite may indicate that a uraniferous province may have existed, hence the Kwitaro rocks, could have acted as repositories for the same. In particular, monofacies-type uranium occurrence should be sought for at unconformable contacts between the lower Kanuku basement and upper Kwitaro sediments especially in the lower metamorphic grade sectors. In the higher metamorphic grade areas, Rossing type uraniferous veins must be looked for.

BURRO-BURRO AND KUYUWINI SHELF FACIES

In this province, there is a preponderance of acid-intermediate volcanics with intercalations of shallow water arenites and pelites. There are no known accounts of significant mineralisation in this province, reflecting in large part the paucity of geological investigations in these areas. However, from published accounts of the geological setting of the area, some definite analogies can be made with similar mineral-bearing areas elsewhere.

The magmatic rocks are represented by granites, alaskites, alkaline granites, and their higher level counterparts, both hypabyssal and extrusive flows and tuffs. Their highly differentiated nature, pervasive fracturing, and intense alteration conjure up images of the Ag-Co-Ni-Bi-As-Cu-U association of the Great Bear Lake area. The associated shallow water continental shelf sediments would hold the same prospects as discussed for the Kwitaro province above. The Pb-Zn-Au association exhibited at Mt. Isa in Australia and Meggen in West Germany show these deposits may occur with or without barite and fluorite. Both of the locations underlain by this rock type in Guyana are well dissected and reconnaisance stream geochemistry, coupled with more detailed geologic work is certainly recommended for the long term.

The relatively clean Muruwa orthoquartzites are isolated for specific discussion because in the author's opinion, this formation exhibits excellent uranium prospects, especially of the discordant 'Texas Coast Plain Type'. Basically, these deposits are found in marginal marine and coastal bar sediments (Morton 1978).

This potential is best approached by a brief summary of exploration guides given by Morton (op cit) for these deposits. Basically one looks for continental marginal marine sediments near an igneous (felsic-intermediate) or metamorphic basement. Preferably, the host succession should contain intercalated shales, mudstones and tuffs. The emphasis is on the occurrence of permeable clastics, through which uranium bearing ground waters could have migrated, eventually to deposit its load of uranium in reducing environments, caused either by the presence of carbonaceous material, or reducing fumarolic emanations. The latter is most probably going to occur at the uncomformity surface below the underlying basement, if the latter is penetrated by faults.

The Murawa unconformably overlies volcanic felsic differentiates and sediments of the Mazaruni Group. It contains felsic emanations, and it is overlain by the highly differentiated, and hydrothermally altered Iwokrama Formation.. It is also highly fractured. An airborne scintillometer survey conducted by Dennison Mines Ltd., over the base of the Roraima formation, identified an anomolous radioactive area near the Muruwa River. The anomaly was not followed up because as Arnot (1969) stated "it is in a heavily forested area and there are no helicopter landing sites within many miles. The appearance of this anomaly and the very difficult accessibility do not encourage further investigation".

It is recommended that the geochemical investigations into the Burro-Burro Group, be supplemented by ground scintillometric surveys for uranium, especially in the lower horizons. Whenever stream geochemistry can isolate possible areas, this could then be followed up by other geophysical surveys eg. gravity to delineate any potential channels, magnetics, electromagnetics, and induced polarisation to detect alteration zones etc. (Note that the Texas Plain-Type deposit is normally surrounded by a pyritic halo).

Barron (1976) reports the presence of an alkaline complex at Muri Mountain in the south east of the country. It raises the possibility of carbonatite-style complexes with their associated mineralisation of niobium, uranium, rare earth minerals and copper as at Palabora in South Africa. One must keep an eye out for such situations in the Iwokrama area, since it is so spatially connected with the Takatu Graben.

GRANITOID ROCKS

These rocks are only understood in general terms, and Table 2 lists the more important directly related mineralisations. In Chapter 6, it was emphasized that some of the granites are auriferous, while others are not. The extremely late stage ones, eg. the Morabisi Granite, are spatially related to large ionic radius elements, and attempts should be made to identify them whenever possible.

At Putareng and Enachu magnetite-hematite bodies occur within a hornblende granodiorite. The relationship of the upper Pomeroon specular hematite to the Barama Group in which it is found, and to the two-mica microcline granite is uncertain. The deposits are estimated to be tens of millions of tons but, with significant amounts of titanium (T_iO_2 up to

4%). This latter contaminant makes the deposits very unattractive as metallurgical iron ore, because the titanium renders iron brittle and there is no known economic method of separation.

RORAIMA CRATONIC SEQUENCES

The Roraima Group of flat-lying, unmetamorphosed rudites and pelites with minor jasperoid (devitrified fine grained felsic tuffs) horizons is thought to be the source of most of the alluvial diamonds in Guyana (Keats 1973, 1974) However, current direction studies by Keats (op cit) Reid (1974) seemingly indicate that the source of the diamonds is to the north and east of the Roraima rocks in Guyana and Surinam Reid (op cit) actually proposes a probable source in kimberlites of West Africa. These diamonds were presumably deposited in an intermediate formation (eg. the Rosebel Formation in Surinam) which on erosion subsequently led to deposition in the basal conglomerates of the Roraima Group.

On the contrary, Schonberger (1974) disputes this thesis based on the spatial size distribution of the diamonds. Schonberger's argument is that the size of Venezuela's and Guyana's diamonds are invariably larger than the West African types from which they were derived according to Reid's hypothesis. He would rather infer a more local source, and suggests a potential relationship between the diamonds and doleritic-gabbros in Sierra Leone, which have been shown to be related to the Cretaceous kimberlites, hence a similar situation could conceivably apply to Guyana and Venezuela where the older dolerites and gabbros are prominent.

The search for kimberlites in Guyana has been unsuccessful. Recently Cominco of Canada through its subsidary McDame Ltd., which was engaged in a diamond project, has reported no success in that area. The fact that no visible diamonds were even recovered from the Roraima certainly leaves the problem in a highly conjectural state. McDame's operations discovered that the diamonds in the river sections were always associated with "a well rounded gravel, which consists of mainly quartz with jasper and sandstone, an obvious product of the Roraima Formation which the Mazaruni drains" (McDame report 1976). They also found that the diamonds were primarily found with a 40 km wide belt of the Pakaraimas. Though no kimberlites were found they did mention the existence of pyrope garnet in the heavy mineral suite, hence an obvious , though not conclusive, inference of kimberlitic materials. The indicators used for diamond in Guyana are rutile, tourmaline , limonite, gorceixite, jasper and quartz crystals.

Lower Proterozoic basal conglomerates of the Huronian Sequence in the Blind River-Elliot Lake district, and other occurrences at Jacobina in Brazil, and the Witwatersrand in South Africa have been known for a long time as uranium - gold metallogenic provinces. Therefore, it is thought that the Lower Proterozoic basal pebbly sandstones and conglomerates of the Roraima Group which overlie unconformably the volcanic flows and pyroclastics and metasediments of the underlying Mazaruni Group would be similarly endowed.

Dennison Mines Ltd. conducted an exploration program in 1969-1970 consisting of an airborne radiometric survey, and follow-up ground checks at seven of the eleven recognized anomalous zones (Donnerstag and Arnott, 1970; Arnott, 1969). The results of the program indicated that the Lower Roraima basal conglomerates were unsorted polymictic instead of the usual oligomictic uranium-bearing strata at the localities quoted above. Secondly, the survey found iron oxides (hematite) instead of pyrite (usually detrital) at the type mineralised locations. There was very little observed uranium mineralisation and the above authors attributed the anomalies to mass effect caused by huge volumes of slightly uraniferous areas. The survey proved that the Roraima and its basement rocks were uraniferous.

Though the above survey did not find any uranium mineralisation, it cannot be assumed that the potential for economic deposits does not exist. The absence of pyrite or sulphides can probably be explained by deep weathering where the iron sulfides will be converted to hematite etc. as is recorded. This could be of more recent parentage, and some stream geochemistry would be extremely useful. The Roraima outcrops over a large area, and the presence of mature oligomictic conglomerates with its inference of excellent reworking, is not to be ruled out. The area should still actively be considered as a uranium prospect.

THE TAKATU GRABEN

This Mesozoic sedimentary basin contains at least 6100 m. of a lower Apoteri tholeiitic volcanic sequence, overlain by the pelites and arenites of the Takatu Formation. Combined with the highly calcareous western sector, and fossil evidence, the environment was described in Chapter 6 as a shallow-water continental or littoral environment.

The discussion of such an environment in the case of the older Kwitaro, and Burro-Burro groups indicated the possibilities of Sullivan-type lead-zinc deposits primarily on the grounds of lithology and inferred structures. In Canada, Kanasevich (1968) actually places the Sullivan deposit in a rifted zone, which hosts the sediments of the Belt-Purcell Group. The similarities therefore become striking as far as lithology and tectonic setting are concerned. In fact, what one desires of the tectonic setting is simply a source of fumarolic emanations, whose end products in the case of the Takatu sediments are represented by jasper occurrences.

The basalts should be considered as a source of copper as in the case of the Keweenawan of Michigan. However, these deposits are not generally very significant. However, the overlying sedimentary cover can be a good depositary for copper sulphides as in the Copper Mine River Group in northwest Canada.

CHAPTER EIGHT

EXTRACTION OF THE PUBLIC BENEFITS

The most basic tenet of any development policy is the maximization of the net benefits of the various forms of economic activity. It will be recognized that a mineral policy, an industrial policy or any sectoral policy are integral parts of a general framework of guidelines which hopefully are harmoniously interrelated so that the overall objective of development is achieved. This section focuses on those measures which can be used to optimize through time, the net contribution of the mineral sector to national objectives. It will first establish the essential elements of a national mineral policy. Following an analysis of rent, specific proposals will be evaluated for the establishment of different mineral development strategies, and their effect on the public share of the benefits flowing from the mineral sector.

The basic elements of a national policy are perhaps best captured in a series of papers by the Canadian Energy, Mines and Resources Department (see Drolet 1974, Buck 1963, Buck and Elver 1970). With specific reference to Guyana and underdeveloped countries in general, the more important, and relevant elements are:

(i) The establishment of the legal and institutional framework within which both the public and private sectors are expected to work. Concepts such as land tenure security, pricing, processing and environmental conservation decisions, domestic control and employment practices must be clearly set out.

(ii) The encouragement of domestic ownership and control of resource industries whenever it is practical to do so, bearing in mind the determinants and characteristics of mineral activity especially with respect to the multinationally-controlled, oligopolistic market structure, and the need for scarce foreign-capital resources.

(iii) The encouragement, whenever economic rationality justifies it, of increasing forward-linked domestic mineral-based activity.

(iv) The promotion of an infrastructural network that rationally services the mineral industry and any other economic activity which is complementary or neutral in use.

(v) The fostering of efficiency-oriented methods which help to maintain the international competitiveness of the nation's mineral industry.

(vi) The conservation of mineral resources by encouraging optimum recovery from deposits, with a concomitant reduction in waste.

(vii) The provision of adequate safeguards for the environment and health of the labour force and the community.

(viii) The promotion of research and development in geological, technological and marketing activities, and the distribution of the information derived therefrom.

(ix) The provision of the environment for augmenting and improving the skills of the work force.

(x) The creation of a taxing system which appropriates from the mineral industry, its fair share of the national revenue requirements.

(xi) The minimization of foreign discriminatory actions against the nation's mineral trade by way of tariffs, non-tariff barriers, or administrative procedures.

(xii) The asserting of the need for mineral-based activity to contribute to and reflect general governmental social, economic, developmental, stretegic and sovereignty policies and goals in a dynamic way.

These principles revolve around the premise that the mineral endowment belongs to the community, and it cannot be overstressed that the legislated mining laws must define quite specifically, and unequivocally the procedures which relinquish rights to this source of wealth to private or other quasi-public sectors. Procedurally, these laws must be as simple as possible, and they should contain an inherent bias against speculation on mining rights. Emphasis must also be placed on the fact that the mining policy must clearly indicate the manner in which conflicting interests will be resolved, as this can contribute significantly to reducing the uncertainty and risk attendant to an already risky (geological) undertaking.

RENTS AND THEIR DISPOSITION

The relationship between the public and private sectors in most market economies appears to be consistently under duress and tension, which are evidenced by the intense competition of both groups for scarce capital and human resources, and by the general conflicts that surround the regulatory functions of government. No doubt, the government as protector of the public good, must undertake to redress whatever productive inefficiencies and distributive inequities may have been a consequence of the all encompassing sweep of the "invisible hand", while the nature and extent of the imperfections will naturally dictate the kind and degree of government involvement which will be necessary to correct them. In the previous sections, the impression is clearly made that the mineral industry must either pose extreme difficulties for the "invisible hand" or it is a separate entity, all unto itself, described by its own unique laws and relationships. This observation seems to be emphasized by the historical fact that the mineral industry has been subject to a large degree of government intervention especially with respect to the regulatory functions of government due largely to the franchising problem characteristic of any natural monopoly, in this case nature-bound. The special tax provisions (depletion clauses, bonus, etc.), presumably attest to this uniqueness. It may then appear that the tensions must firstly have their origins in the different perceptions of private and public agents with regards to the nature of this uniqueness and secondly with regards to the prescriptions that will be required for its accommodation.

An analysis of rent must explicitly take into account, the returns to the factors of production that are necessary to keep them in their state of employ or induce them to move. Reverting to an abstraction of perfect competition, it is evident that the entire product will be exhausted if labour, capital and natural resources are compensated at their marginal value products. Likewise, labour will be paid a wage consistent with its productivity, capital will obtain a rate of return consistent with its risk-class, and the natural resources will return a value based on its locational parameters and quality. Even with significant imperfections in the market where the above conditions do not hold, some part of the total product that is in excess of the returns to labour, and capital must be logically attributed to the natural resource. Secondly, if labour, capital, and enterprise receive their opportunity incomes, then they will not transfer from their existing state of employ to another. The surplus in excess of the income required to keep labour (including enterprise) and capital in their state of employ is to be considered as rent, and it should be observed that it can be effectively withdrawn without affecting the allocation of factor inputs to the activity.

In an accounting sense, rent is equal to the Cash Flow less Capital Recovery allowances. The relationship of rent to profit, interest, depreciation, receipts and expenses are given in the following equations:

(Cash Flow) = (Gross Receipts) - (Current and Ancillary Expenses)

(Profit) = (Cash Flow) - (Depreciation)

(Rent) = (Cash Flow) - (Capital Recovery)

(Capital Recovery) = (Depreciation) + (Interest)
(Rent) = (Profit) - (Interest)

As Gaffney (1977) pointed out, the marginal mine is typified by the equality of capital recovery and cashflow, hence producing no rent. When capital recovery is slow (i.e. spread over a long period), interest payments become the dominant element as the depreciation element becomes correspondingly small. Therefore, the equality of interest and profit in the marginal mine will result in a large profit income stream even in the absence of rent. This is a typical feature of slow, long-duration activities such as mining, and it is therefore crucial for one to isolate the concepts of profit and rent when attempting to decide what should be appropriated by whom and by how much.

SOURCES OF RENT

Gainer (1975) quite lucidly described the determinants of rent and ascribed it to four principal sources, of which two can be related directly to the uniqueness and finiteness of mineral resources while the other two are more generalized cases of market imperfections due to monopoly control, imperfect foresight and to some extent imperfect possession. The first source of rent is a static one where differential net incomes are generated by the mineral resource due to differences in their quality, accessibility and proximity to a market. In such circumstances, the better placed deposits will earn opportunity incomes in excess of that derived by the least favoured deposit which earns the minimum return that is necessary to allow exploitation of a deposit of that type.

The second source is due to the returns which specifically derive from exploitation over time of a stock of finite life. It has been shown in the theory of production (Scott 1973) that such an industry could ultimately be characterized by increasing long run marginal costs, hence known units of inventory held in the ground and sold in the later period at a point of equality of the higher long run marginal cost and price will obtain a supranormal return in relation to the historic finding costs per unit which is in fact a rent. Naturally, this assumes that in all periods, all factor inputs earn their opportunity incomes and that the capital loss suffered by the maintenance of an illiquid inventory is accounted for. In fact, Gainer illustrated that even in situations of a constancy of real marginal costs, supranormal paper profits can develop due to increasing money costs, as the earlier established units will be sold at the new higher price that is coincident to the higher money marginal cost. However, it must be borne in mind that real profits are not increased in terms of their investment goods purchasing power.

The third source is due to the condition of a monopolized industry where a specific imperfection allows a surplus to be generated on account of the price being consistently greater that marginal cost (= Marginal revenue). In this circumstance, the sources of rent are two fold, as apart from the monopoly profits, earlier established inventory will also create a rent as described in the second reason above.

The fourth source is due to sudden changes in prices or technology or other factors external to the industry which will generate transient surpluses (or losses). Because of their transient nature, the surpluses are best considered as quasi-rents and may require special treatment, since over time it is possible for them to be neutralized by removal of the barriers to the imperfection, or they may be compensated for by losses at another time.

DISTRIBUTION OF RENT

The apportioning of rent between the industry and the public sector (via the regulatory and taxation functions of government) constitutes one of the major sources of the conflict between the two groups. Gaffney (1967) observed that "the disposition of mine rents is an integral part of a nation's political structure, with decisions made as much for political as for economic reasons". The problem is similar to that of the granting of a franchise by government to a private monopoly to gain the cost advantage of scale, but then having to regulate the enterprise so that the public does not suffer the higher prices and profit rates more possible to the monopolist. In the particular case of developing countries, Roberts (1967) quite astutely recognized that "the most resented aspect of private enterprise in developing countries is the non-functional appropriation of rents by private individuals is a source of concern especially since it can be used as a means of accentuating the imperfections in the credit and financial markets by providing their appropriators with low-cost forms of internal financing which may not necessarily be competitively deployed. Gainer (1975) highlighted the fact that it can also be a source for further rent generation and of course the inevitable increasing concentration in the industry.

Advocates in the mineral industry typically refer to the wasting nature of a finite mineral stock, and the concomitant reduction in value of their asset as justification of their "right" to all or a major part of the rents. Their argument is often times supplemented by the view that the high capital intensity and high-risk nature of mineral ventures constitute enough of a rationale for rent retention. At the extreme, to the point of really begging the question, some proponents in the mould of Zimmerman would even claim that the mineral resource is valueless until the industry makes it available.

Proponents of the public's claim to rents are quick to demonstrate that the last argument above is really immaterial and inconsequential, since prospectors concede that undiscovered deposits have value by their being prepared to pay landowners lease bonuses and land rents, while agreeing to share portions of the expected income for the right to explore. Secondly, all inputs complement and augment the value of each other when combined in productive activity, therefore it is not correct to impute the whole product or output to one input because of notions of its indispensability (Gaffney 1967). Thirdly, government sources would argue that allowing the aggregate value of a mineral find to pass on to the prospector may result in industry over-investment in exploration and production at the front end, and will probably eliminate the full value of the find as in the case of unregulated common property resources. Rather, it is economic common sense to regulate exploration activity by letting the marginal rather than the average product call forth any further effort.

Establishing the case for public retention of rents, Scott (1976) asserted that all surplus value is created by society's actions with respect to the public domain, hence government should withdraw the surplus as a "benefit tax" on its behalf. Since mineral resources are considered to be the natural heritage of society, and they are subject to exhaustion, then the costs of depletion and the subsequent depopulation and relocation costs must be accommodated. He argued that the surplus should be retained and deployed by society in activities that could provide other forms of reproducible capital which would compensate for the loss in value of the resources and the fall in standard of living and human misery created by the depleted resource. On efficiency grounds, it can be argued that since the surplus can be appropriated without affecting the deploying of labour and capital, then it should be removed and subject to scrutiny of competitive market forces, while making the value judgement that government can be trusted equally well to make these decisions, since they are better placed to decide on the required social and private capital mix. Morrissett (1967) has also argued that the cost of discovery though stochastic can be easily separable from the residual value through market prices", hence it could be expensed explicitly instead of conferring rights to rent.

With respect to the disposition of rents, Roberts (1967) identifies six methods which correspond to different political structures. These are:

(i) Taxation of rent as a means of asserting national proprietorship.

(ii) Promotion of labour intensive processing in extractive countries by domestic wage and price policies.

(iii) Nonfunctional rent retention by resident or absentee landlords.

(iv) Rent absorption by featherbedding and inefficiency.

(v) Rent absorption by military and political manoeuvres of private owners for power acquisition.

(vi) Totalitarian dictatorship of the Left or the Right.

Gaffney (1967) adds a seventh alternative of leasing of public lands. In most cases, alternatives (iii), (iv), (v) and (vi) are disastrous, while (i) and (ii) offer better possibilities for orderly development. Even though option (ii) might involve inefficiencies, in the special case of surplus labour economies, it may be the course of action that best offsets the costs due to noncompetitive deploying of scarce capital, of course, techniques permitting.

COLLECTION OF RENT

In the remaining discussion, it will be assumed that stability in political and institutional structures exist, and that the governmental bureaucracy has designed tax laws which have both efficiency and equity considerations as of paramount concerns. The equity considerations of the tax measures would concern themselves principally with the distribution of the output and the returns to factor inputs across industry, while the efficiency aspects would be concerned with the effect of the tax on the static and intertemporal allocation of resources in the neo-classical sense. Considering methods of rent appropriation, one must be ever mindful of Gaffney's (1977) analogy of rent as the fat without the lean, and that "the less of the lean one cuts into by clumsiness, the more of the fat he can secure without imparing functional incentives."

The method of rent collection is first of all directly related to the system of mineral development employed, if in fact the system is consistent with rent generation.One can recognize four distinct systems of mineral development; they being the "Discovery System", the "Leasing System", the "Concession System" and "Government-run System". These systems are not mutually exclusive and can be found combined in varying degrees depending upon the circumstance.

THE CLAIMSTAKING SYSTEM

The method of claimstaking as practised in Guyana and elsewhere is a typical form of the Discovery System, where rights are appropriated after discovery with the payment of a token amount. (See Appendix 15 for schedule of fees and revenues collected). The entire value of the find accrues to the operator whose principal objective is maximization of the value added in mining (Tussing and Erickson 1969).

This system seems well adapted for relatively unexplored areas, as the foregone rent can best be viewed as an incentive to exploration. However, when knowledge of the economic potential of the area increases, the flood of new entrants quickly results in the dissipation of whatever potential rents which may have existed. It has been shown in Chapter 3 that the situation is exacerbated by diseconomies of scale in exploration, due to the increased competition, smallness of tracts, and perhaps paucity of funds which is so characteristic of the little claimstaker-prospector. The government's role is minor and seems simply to be one of dispute settling, claim distribution and royalty collection.

Chapter 3 has already commented on the failure of this kind of structure to foster growth in a Guyanese context, and it is recommended that it must be used only after an area is thoroughly investigated by the Mineral Development Unit, or in cases where this Unit has no plans for specific areas in a 5-year period. In the former case, it eliminates the inconvenience of claims being tied up, while allowing the small prospector to work in identified areas. In the latter case, it reverts to its traditional function of providing information in unknown or unoccupied areas. Should the Mineral Development Unit decide to work in a specific area to which claims have already been assigned, it must identify and publicize this fact with the understanding that should a large economic prospect be found, the prospector would be given the options of immediate compensation, or to be a major partner in a mining co-operative, or if mining is done by the State Mining Corporation alone, then he would retain a royalty interest for a specified period. The right to retain a claim should be only given if actual prospection has been done. The current requirement for boundary-line clearance is definitely inadequate as it permits unproductive land use.

An interesting feature of the Guyanese Mining regulations is the provision for the award of "Reward Claims" to a prospector for discovering gold or precious stones further than 16 kms from any known deposits. A maximum of six reward claims can be issued free of charge. This seems to be unnecessary, and counter productive incentive scheme, since any prospector would on his own volition attempt to acquire any ground which he considers has potential. Secondly, because of the scale of his operations, he is unable to beneficially occupy these extra claims, and as argued above, they should be assigned to others who will conduct active work, defined by a required duration of work, or funds expended.

There is provision in the Mining Act for the assignment of an Exclusive Exploration Permission for relatively large areas (in excess of 500 acres), to persons or groups of persons who are financially capable to carry out exploration activity. They have an initial duration of three years, and can be renewed annually. The rental is graduated from 10¢ per acre in the first three years, to 20¢ per acre in the fourth year, and 25¢ in the fifth and each succeeding year. The nominal nature of the fee in the first three years is aimed at giving an exploration incentive, while the higher later values are aimed at discouraging unnecessary withdrawal of the land from possible productive use. This is an extremely good feature of the plan, and coupled with the requirement that the work must be satisfactory to the Minister, it does possess adequate safeguards, though its rent collection ability will always be in doubt since the value of the resource is unknown.

LEASING SYSTEMS

The Leasing system is a more advanced form of mineral development with respect to the increased role of government and the pervasiveness of regulatory measures which have more complex objectives. These objectives may be either maximization of economic rent and government revenues, allocative efficiency, or they may be a subset of the government's fiscal armament designed to affect the course of the national economy. The argument was made that the state acting on the community's behalf, attempts to appropriate all rent accruing to the resource. The leasing system is a means of appropriating this rent by the setting of a price for transference of the publicly owned resources into private hands.

A lessee basically can pay for the right to explore and exploit a deposit by either one or a combination of a constant yearly rent, a royalty or severance tax based on the value of the output, a lump sum amount such as a lease bonus, or some form of taxation which may take the form of an income, net royalty or property tax. Each of these measures affects the production decision differently, and as such has different allocative effects on the deploying of inputs. The neutrality or allocative effects of any of these instruments would be recognized by their effect on marginal resources, and the change, if any, of the return to factor inputs and output, while the measure would be considered as successful depending on the objectives that were set.

The amount a lessee pays can be established by statute, or by competitive bidding or by negotiations. In Guyana, it is established by statute, and is as follows:

20¢/acre/annum for gold, silver and valuable minerals

20¢/acre/annum for	precious stones
40¢/acre/annum for	gold, silver, precious stones and valuable minerals (presumably base metals or others)
20¢/acre/annum for	dredging of gold, silver, precious stones and valuable minerals
20¢/acre/annum for	dredging for minerals

(Laws of Guyana Chapter 65:01, 1973)

The true value of the cash bonus (or any fixed lump sum payment) as a rent-appropriating device is completely arbitrary, except the state is completely cognizant of the expected value of the deposits to which it is conferring rights. This latter condition is extremely restrictive, since geologic uncertainty at the time of lease acquisition is still quite large. If, however, there are numerous competitors seeking mineral rights, then the introduction of a bidding system might allow an easier quantification of the amount of resource rent. Since companies determine independently the present value of the deposit, the maximum amount anyone is willing to forego to obtain those rights is indeed a close proxy to the resource rent.

However, Peterson (1977) reminds us that firms would not bid the full expected value of a tract even if they knew the correct value, because of risk aversion. Though the bonus-bidding system has the simplicity of a large lump sum payment, it has the tremendous disadvantage of reducing any potential surplus because of the increasing risk to the companies of making large front-end payments. Increasing risk will naturally reflect itself in a higher supply price of capital, which price will also be augmented as the firms attempt to recapture the opportunity income of the sum paid over to the government. The fact that the bonus is calculated on a present value basis with a privately determined discount rate (higher than social rate) will also reduce the size of the bonus. Mead (1977) argues a strong case for the bonus bidding system, and suggests combining it with a scaled royalty payment, and/or using a phased bonus payment plan to reduce the disadvantages mentioned above. He would, however, concede that the element of competition is essential to the working of the bonus bid system. Such competition is notably sadly lacking in Guyana and underdeveloped countries, and is not to be recommended, especially in view of the host of geological and commercial imponderables that exist.

A variant of the bonus-bidding system is the work-committment bidding. In this case, no bonus is paid at the front-end, but rather the operator promises to undertake a certain amount of work (exploration, development, etc.). The rationale for this system is that the foregone bonus would be used to generate income which would contribute to government revenue via royalties and other tax measures, coupled with the ancilliary employment, resource self-sufficiency, trade improvements, etc. Erickson (1977) finds that this system is superior to the cash-bonus system if the objective of government policy is the maximization of physical output, since the amount a bidder will promise to spend will exceed the sum of the cash bonus and the amount he would have allocated to development of the tract under the cash bonus system. However, if the objective is maximizing social benefit, the work commitment system is a suboptimal solution and is in fact a subsidy to mining viz-a-viz other industries.

The requirement of bidding, and the competition it implies are crucial to the system's success, and as pointed out in the preceeding section on the cash bonus, it will not work in an underdeveloped atmosphere, except the government is mindful of giving mining a subsidy, then gambling on the fact that it could appropriate the rent if the venture is successful.

Unlike bonus leasing methods, royalty, severance taxes and profit-sharing schemes introduce a degree of risk-sharing between the investor and the state. These payments that are conditional to the level of production or income are in effect a form of government insurance which will reduce the social welfare loss which would result from risk aversion on the part of the investor. Presumably, firms will allocate capital more efficiently (in exploration, development and production), hence government revenues could conceivably be higher. This is, however, counterbalanced by the fact that a royalty based on gross or unit value, and a yearly rent all contribute to increase the marginal cost (hence decreasing net price) of the operation while exacerbating the tendency for high-grading and closure of marginal mines.

Either of these measures or a combination of them can be used to effect appropriation of rent with allocative effects on factor inputs and intertemporal productive output. Gardner (1967) argued like Gray (1914), Herfindahl (1967), and Vickrey (1967), that they are inefficient redistribution instruments because of their non-neutral effects on efficiency.

The obvious preference is for specific tools that are designed for redistribution, while using measures such as an ad valorem royalty, which has a relatively neutral effect on resource allocation, as a means of appropriating the rent. In this regard, Vickrey (1967) specifically expressed a preference for an ad valorem royalty on an in-situ value, as there are some non-neutral effects, though minor, associated with an ad-valorem tax on realized value, because a tax based on realized rent is always shiftable. However, the major problem with such a base is obviously the difficulty of assessing in-situ values. If these values can be approximated, then this base approaches an excess profits tax which is calculated by the expensing of labour, materials, and a return on physical capital invested in exploration and development from the future gross receipts. Along these lines, Gaffney (1967) suggested that a tax levied as an annuity whose value is the present value of the deposit times the tax rate will be neutral as to discovery as well as production. Of course, the level of output, prices and hence income are very uncertain, hence difficulties may arise in computation. McDonald (1967) and Steele (1967) advocated the use of a value added tax essentially of the consumption type as a means of appropriating rent, because of its relative neutrality especially where supply elasticities are small. This tax base is comprised of total revenue from product sales minus purchases of materials, minus purchases of new depreciable assets, but with no deduction for depreciation, hence inferring that immediate expensing should occur. This latter provision of course may be quite unacceptable because of the potentially long tax holidays that may result.

A flat rate corporate income tax that attempts to maintain equality of treatment of all industries regardless of their risk class will be extremely burdensome on high-risk, capital-intensive projects, such as mining. However, expensing of various sorts at the front end can reduce this burden, but it must be recognized that increasing the amount and kind of expensing provisions such as depletion leaves room for increasing the shiftability of the base, hence what misallocations may have been averted inter-industry wise, may well appear in the industry itself over time. The flat rate corporate income tax has the added disadvantage in that it does not discriminate between income to labour and capital as opposed to income to resources-economic rent." The fact that all expenses are deductible (albeit over a variable time frame) does create some room for overmotivation of exploration, while it typically favours large concerns which have other sources of income from which losses can be written off in the current period if the expensing is immediate. Smaller marginal firms can be theoretically eliminated from the industry by unfavourable current expenditures, and they cannot appropriate this benefit for want of other income against which they could expense it.

Though tax neutrality and its implication of equality of treatment of all factors may be a desirable policy, Gaffney (1967), taking a rather realistic stand, asserted that non-neutral tax policies may be more desirable than neutral ones in situations where market imperfections etc., are to be reduced. For example, a property-tax though it tends to increase current costs and increase the depletionary tendencies of the firm, also has the effect of restricting the practice of holding excess resources, thus reducing monopoly tendencies. It was shown earlier that a competitively determined cash bonus has the same effect. The depletionary tendencies will be reduced by the fact that property taxes are generally capitalized into lower net prices, while if mine improvements are expensed, then there is hardly as great an incentive to increase capacity as quickly. However, any depletionary attempts considered excessive can be countered by a countervailing depletion tax based on the user cost concept. Such a combination can be quite effective especially if this modified property tax that expenses development expenditure is based on the in-situ values.

These in-situ values are obviously unknown in the pre-exploration stage, hence they cannot be called on to guide the government in establishing the rents that should be appropriated. In developed market economies, where more information is generally available, and in which equity and recently debt-financing is so prevalent, the assessed values for stock, or credit purposes can be used by a taxing authority as a guide to in-situ values, with provisions being made for periodic reassessment as more information becomes available. This form of modified property-tax has the advantage of being neutral to exploration, as it increases the base with favourable information on a property and decreases it with unfavourable information. It also engenders an element of risk sharing between the government as leasor and the taxpayer as the lessee. It affects marginal resources only slightly, while taxing heavily non-enterprising absentee landlords who are a distinct feature in underdeveloped countries. One other major advantage emphasized by Gaffney is the ability of such a tax to promote competition because of its burdensome incidence on unused hoarded deposits, and the resulting reduction in the lease prices that would occur on their release. The resulting reduced credit base of the large mineral holders would then allow greater access of small firms to scarce capital, and unlike the income tax, it treats all firms equally.

One cannot help observing that the above measures aimed at appropriating resource rent in the Leasing System, assume a tremendous degree of sophistication, knowledge and strength on the part of the state apparatus, coupled with a large number of competitors for lease rights in an economy that has a well-developed capital market. These features obviously do not exist in an underdeveloped economy, and hence the policy instruments in their forms described may be highly inapplicable. For the underdeveloped country, therefore a taxing system must be found which maximizes rent available for taxation, and which will offset the ignorance of the government with respect to the geological and commercial parameters, while at the same time affording the government the opportunity to meaningfully attract capital resources at reasonable terms. The Concession System and the system of complete government control have evolved to fullfil this need, but in recent years a Resource Rent Tax which resembles an excess-profit tax has surfaced (Garnaut and Ross 1977), and is pregnant with possibilities for the underdeveloped country.

The Resource Rent Tax (RRT) as proposed by Garnaut and Ross (1975, 1977) is built on the assumptions that

(i) Companies investment patterns depend on a base level of after-tax return on investment

(ii) Investors are risk-averse

(iii) Government is not subject to risk aversion over its revenue from resource projects, and is instead, simply concerned with maximizing expected value of revenue.

(iv) There is no effective competition for mineral rights.

Basically, the RRT is a company income tax with no deductions for interest payments, immediate and total deduction for capital expenses, with unlimited carrying forward of losses adequately discounted. However, after a threshold level of return to investment (equal to the supply price of investment) is reached, the marginal tax rate is much higher than for normal company taxes. The supply price of investment which naturally depends on general lending and borrowing rates, degree of expected risk, and investors pattern of risk aversion, has been found historically to be about 15% to 18% in underdeveloped countries during the late 60's and 70's (Mikesell 1975). The assessment of RRT is based on annual net assessable receipts (i.e. assessable receipts - payments) from the beginning of expenditure on the project. The assessable receipts differ slightly from standard accounting form in that they do not include any loans to the company nor receipt of interest and dividends, nor is a positive change in inventory included. Payments are for services rendered in the accounting period and do not include repayment of loans, interest, dividends, bonus issues and provision of capital. Exploration expenses are counted as a cost to the operation.

Using the supply price of investment as the discount rate, the first appearance of a positive net present value constitute the tax base which can be taxed at a high rate of tax. It is immediately obvious that the RRT is tantamount to a zero tax rate up to the time of recovery of capital, and in fact this initial period is in every way a tax holiday, which could be embarassingly long, while the tax base could be quite irregular depending on market patterns, and output. These features can be eliminated by combining the RRT with a normal corporate income tax, or a royalty (ad valorem preferably) which will be deductible for RRT purposes. The effect would therefore be to guarantee the investor his investment, while the government starts collecting some revenues in the initial years, which revenues will increase significantly as a proportion of the tax base, as soon as the threshold supply price of investment is met. Alternatively, the initial threshold return on investment can be lowered, and other graduated levels of marginal tax correspondingly adjusted to ensure that the investment is guaranteed.

The government does assume a large part of the risk by permitting the investor his return on investment at an early stage, but of all the tax measures, it goes furthest in instilling confidence, and risk reduction on the part of the company, which will translate these lower risks into a lower supply price of investment, which will in turn mean quicker returns to the tax authority. Expost taxes based on the actual income stream generate large uncertainties, and a definite deterrent if foreign investment is to be solicited. The fact that the RRT is based on revealed profitability prevents the company from exploiting the government's relative ignorance. As Garnaut and Ross (1977) observed, the RRT only requires an assessment of the supply price of investment by the government, while the other forms of rent appropriation, requires government knowledge on both the probability distribution of costs, prices and supply price of investment. However, one must agree with Mead (1977) and Genkins (1977) that even though the investors return is secure, the incentive for shifting of tax burden increases with the higher marginal tax rates as required by the RRT. This would require greater vigilance by the government in the accounting practices of the enterprise, so that transfer pricing, etc., can be controlled.

It must also be observed that the clear preference of the Guyana Government for joint-ventures can very easily be accommodated in the RRT approach. In fact, it is a more desirable arrangement from the Government's standpoint, since the initial threshold supply price of investment is applicable to the company created by the partnership of the two parties. Defined in this manner, the state therefore shares in the revenues of the project from the first year of operation. The private investor is still guaranteed his supply price of investment, but it is over a longer time frame. In other words,the first threshold after which a tax base is created relates to the entire joint-venture company. The second graduated threshold above which the tax level increases can be identified with the point at which the company has achieved its entire supply price of investment. After this point, higher tax levels can be instituted.

In this way, both parties derive some benefits throughout the mining operation.

Gaffney (1967) referred to an interesting phenomenon associated with an income tax on realized economic rent which probably is of much greater significance than he attributed to it. He described the tremendous disincentive caused by the conversion of cash income into psychic income by the taxpayer, who becomes undermotivated because he sees a large part of "his income", even though it is economic rent, being withdrawn. In common terms, he sees himself as the goose that laid the golden egg which was ruthlessly taken away from him. Naturally, the operator chooses to disregard the fact that the terms of his survival (via complete and immediate expensing) have been completely guaranteed, albeit perhaps even more so than his less fortunate kin. Whatever its origin, this psychic income is a formidable force with which to fight and it almost appears that it must be explicitly accommodated in the form of a visible allowance in order that no demotivation occurs. Whether it can be given a physical form is a subject for research which will take its toll of resources and time.

In Garnaut and Ross's (1975, 1977) proposal, a graduated series of thresholds can be used to effect the sharing of economic rent between the state and the investor. The first threshold is the supply price of investment while all others are rent sharing devices, above which the marginal tax rate increases. The total tax rate was arbitrarily suggested at about 80% to 85%, which figures Mead (1977) contend will lead to demotivation. The problem is clearly to quantify the portion of psychic income which the operator is prepared to forego before he becomes undermotivated to produce. It is here suggested that one parameter that could be used can be achieved by asking the question "What would the investor have lost if the deposit was not commercially profitable?" The answer is clearly, his exploration funds. It may not be farfetched to suggest that the fear of the loss of this amount might be the major source of the psychic income effect. Now, after the investor has attained his first threshold (= supply price of investment including exploration costs), then the marginal tax rate can be adjusted to the higher level which permits the sharing of the rent in such a proportion that the absolute value of the exploration expenditure, appropriately discounted with the time of appearance of a surplus as the new time reference, can be written off over the remaining life of the mine, or to some period where the parties involved may opt for a different form of arrangement such as state management with licence fees, management contracts, or complete state ownership.

The proposal has the advantage of explicitly identifying a sum which is in effect a risk premium, and it will consequently increase the government's ability to encourage the investor to use a lower supply price of investment. Secondly, it clearly sets the "bottom line" while accounting for the rather nebulous psychic income. It provides a basis for more exploration activity, while any tendency at over-exploration can be countered by the government setting a ceiling on the allowable exploration level in any given time period. It also removes the arbitrariness of any given marginal tax rate which would be subject to a plethora of interpretations, and hence demands and counter-demands.

One of the basic factors that set mineral resources apart from other forms of capital is the fact that depletion occurs through use. This depletion involves a real cost to the owners in terms of the physical amount of mineral used up, and tax policy has attempted to reflect this difference through provisions that have been made from time to time. It should be recognized, however, that depletion as recognized by Gray (1914) and later refined by Herfindahl (1967) should be construed as "the loss of future rent caused by realizing present rent", hence any deductions in the current period for depletion should reflect a value discounted over the life of the mine. With long life as expressed by reserve/output ratios that are as large as was indicated as operative in the mineral industry, it is possible that the true discounted value of extracted ore would be negligible. It is only in the case where exhaustion is imminent that spot values would be equal to the depleted portion, hence proper practice would dictate that the deduction from current income should reflect this reduced value. This feature of corporate income tax has been one of the major areas where the industry has been undeservably favourably treated as current practice allows a depletion allowance based on either a percentage of realized gross or net values, or on costs incurred; concepts which have absolutely no relationship to depletion, but rather can be construed as an outright subsidy.

The conventional use of the term depletion allowance whether "earned" as in Canada or "automatic" as in the U.S. has been an unfortunate use of terms, when the expressed motive of the allowance is to facilitate quick write-off of capital. Even though tax provisions permit expensing of capital (including exploration costs), the mineral industry has traditionally justified their right to depletion allowance based on the ultimate exhaustibility of the deposit, though not subjecting themselves to the true economic ramifications of the term.

If one can conceive of mineral rights as being the exclusive preserve of the state, which in turn grants only production rights to the private concern, a strong case can be made for the state to derive an allowance for depletion based on the discounted value of the current production over the remaining life of the mine. In the case of Guyana and the majority of states, the mining enterprise's lease contract is more reflective of production rights, as all resources in the country are vested as of right in the state apparatus. Simply put, ownership of the resource rest inalienably with the state, while ownership of the production is vested in the mining enterprise.

CONCESSION SYSTEMS

The Concession System of mineral management is essentially a package (contract) on rent sharing between the government as landlord and the investor, involving exploration, development, and sometimes production, with stipulations concerning infrastructure, employment objectives and the myriad of concerns in a development programme. It is typically employed by the underdeveloped country where bottlenecks in factor supply are common, and competition for mineral rights non-existent.

The Concession System, as pointed out by Tussing and Erickson (1969), makes the fewest demands on the surrounding economic system, but makes great demands on the sophistication and technical capabilities of the government in the bargaining and implementation stages. It lacks a precise measure of success which is invariably assessed in terms of a nebulous "maximum contribution to economic development". It should be stressed that mineral sectoral responsibility and success should logically be guided by the maximization of net revenues after allowing for the cost that are necessary to the operation. In this regard, infrastructural costs that are necessary for the operations must be charged against the operation, while any spurs should justify its existence rationally. One cannot lose sight of the fact that requiring the concessionaire to build a road, a processing plant, or schools, may be good but that it might not be the most efficient way. With these reservations in mind, the concession system may be a likely alternative to the RRT, which seems superior on efficiency grounds.

GOVERNMENT-RUN SYSTEM

The government-run system has been commented on in various sections of Chapters 3, 4 and particularly Chapter 5, where the options open to the state were considered. This section acts as a summary of those views, while it introduces the rationale for direct government presence.

The other three systems described varied in the amount and kind of involvement by government in mineral activity. The claimstaking system required the least amount of government presence, which was essentially of a dispute settling and rent collecting role. The various leasing and concession systems required a greater degree of government involvement as the regulatory controls evolved to fulfill more sophisticated objectives. The three systems emphasized some degree of partnership between the state and the private concerns; while this final organizational form emphasizes no role for the private sector.

The point is often made that since mineral exploration and development are pervaded by externalities, scale economies, and high-risk, then private production must by definition be inefficient (Waverman 1977). It is further argued that since government can pool risks across all taxpayers, hence becoming more risk neutral, then a prima facie case is developed for government involvement. When these factors are added to the social functions which cannot be met by private ownership, then this involvement should be one of public ownership.

The argument sounds fine when left in a vacuum and one accepts the rather questionable assumptions of risk neutrality. However noble its intent, the capital intensive, oligopoly-dominated realities of the mineral industry cannot be ignored. Underdeveloped countries, like Guyana, have been shown to be characterized by a deficiency of capital, skills, and techniques. The finance-raising capabilities of the small, underdeveloped state is indeed quite limited, and even when it comes, it is normally project specific with a multitude of conditions attached.

If the argument for government-run operations is an argument for small scale developments with limited financial needs, then it is certainly feasible and to be encouraged. However, if medium and large-scale projects are to be contemplated, the government is best advised to seek the partnership agreements, which make the least demands on its limited resources. Effort should be placed into assuring that the government receives a fair bargain rather than burdening it with all the risk-taking.

Guyana is fortunate in having a well developed bauxite sector which should now be playing a greater role in overall mineral development. The areas for this involvement were identified in Chapter 3, and it is to be noted that the scale of operations originally planned for the mining corporation are initially relatively small, since Guymine's carrying capacity for projects is also quite small. Should large mineral developments be contemplated, then realities and reason would suggest that partnership is the course to follow.

CHAPTER NINE

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The establishment of the potential contribution of the non-bauxite mining sector to future development in Guyana was one of the principal objectives of this study. Chapters six and seven first attempted to establish the potential presence of base-metal deposits, which were to constitute the major focus of the thesis in terms of the conditions which were necessary for their exploration and exploitation.

In chapter six, a complete review of the Guyanese geology and lithostratigraphy was attempted, and a new geological map (Figure 7), produced. Significant changes from the provisional map of Guyana (McConnell 1962), include the incorporation of the geology of Southern Guyana, and the redesignation of the 'Barama-Mazaruni Assemblage' of McConnell (1962) as the 'Barama-Mazaruni Supergroup.' The latter redesignation was performed to establish the integrity of the 'greenstone-style' environment which is present in the northern basin of Guyana. The review also facilitated an appreciation for the fact that the Barama-Mazaruni Supergroup of Northern Guyana and the Kwitaro Group of Southern Guyana simply represent products of normal basinal sedimentation, with the former being of nearshore marine origin and the latter of an epicontinental origin. Therefore, given the petrogenetic setting, theoretic metallogenic modelling then becomes possible. This helps to remove the 'psychological barrier' of the previously accepted tectonic break, which was alluded to in the introduction to that chapter.

Specifically, this thesis identifies three major structural zones which are interpreted as major areas of deepseated crustal dislocation in Northern Guyana. It is further suggested that mantle material might have been tapped in these tectonic zones, therefore resulting in the obvious alignment of mineral occurrences and geochemical anomalies. The three areas are:-

(i) The Groete Creek - Peter's Mine Zone.

(ii) The Makapa - Kuribrong Zone.

(iii) The Baramita - Eclipse Falls Zone.

The search for base-metal deposits then should involve relatively intensive work in these three zones, since the probability of occurrence of a source for the minerals, a host for their eventual deposition, and the required tectonic preparation are greatest.

Punwassee (1970) and Hamilton (1968, 1970) have documented the relative success of conventional geochemical methods in defining mineralized areas. However, a significant proportion of the geochemical work was not properly supplemented by geological leads. In particular, the experience of Hamilton (1968) at Groete Creek can be ~~sited~~ as a case where geochemistry by itself is powerless in delineation of potential ore bodies. His structural analysis and geologic deductions have indicated the possibilities of extension of the Groete Creek ore zone which is displaced by north-south normal faults. In particular, the leads afforded by extensive carbonaceous, and cherty horizons should be followed quite closely for reasons already discussed.

Base metal mineralisation of the massive and disseminated types are distinct possibilities in the greenstone belt of Guyana. It is up to the geological surveys to plan a systematic program of geologic, geophysical and geochemical work to find these bodies, bearing in mind that it is the quality of the work which will be the major factor in the success of the effort.

Phase I of such a program should involve saturation geological mapping of the zones identified above. At the same time, geochemical sampling in areas not already covered within the zone should be done, so that the regional geochemistry of the area can be defined, and possible displaced anomolies (due to faulting,etc.)can be identified. The geological mapping would principally stress the identification of features, such as alteration patterns, proximal volcanic ejectamata etc., which have consistently been identified in similar metallogenic terrains. It should be stressed that whatever samples are available in Georgetown, should be thoroughly analysed with this bias, so that actual field costs can be reduced.

Work should be initiated in the Groete Creek-Peter's Mine area, since it represents the best current prospect in terms of potential mineralisation, and accessibility. At the same time, it complements and preceedes the activities of the state corporation which should be engaging in active drilling at Groete Creek as recommended in Chapter 7.

Uranium is the most likely energy alternative to oil in the twenty-first century. This commodity is currently being intensively searched for, and developed on most of the continents of the world, and Guyana should not be an exception. In Chapter 7, the conditions for uranium occurrence and exploration were defined. It must be noted that to this author, the Muruwa Formation is an extremely good prospect. It possibly is a better target than the Roraima which contains polymictic basal conglomerates which signify an undesirable degree of immaturity of the sediments. The oligomictic, coarse-grained quartzites of the Muruwa conveys the impression of a thoroughly reworked, hence greater concentrated sequence. It is strongly advised that the entire Burro-Burro Group be considered as one unit of study, which would involve geological and geochemical investigations along with a radiometric survey. As an entire unit, the exploration effort would include the minerals identified in Table 29.

Southern Guyana is still a relatively unknown entity. However, as indicated by the classification in

Table 29, areas with similar environments have been quite prolific mineral producers. In particular, the uranium potential of the Kwitaro Group cannot be underestimated. Its environment is not very dissimilar to that of the Muruwa, though its higher metamorphic grade would infer that Rossing-type uranium deposits should be looked for quite closely. As such, careful attention must be paid to the pegmatite development at the marginal contacts with the later remobilised, intrusive granites, and wherever the Basement-Muruwa contact is observed.

Even though it is true that locational characteristics would affect to a large extent the economic potential of a deposit, the national mineral inventory must not be as rigidly constrained by remoteness. Southern Guyana must be mapped in greater detail, as its environment reveals that there is potential for mineralisation. In particular, it is to be strongly recommended that a permanent sub-office of the Geological Survey be established at Lethem in the Rupununi, so that operations in Southern Guyana can be serviced. This sub-office can include a mini-lab, drafting facilities, and stores for the local operations. The Southern Guyana geological operations can start at Marudi Mountain, with a combined programme of collaboration with the mining corporation which should start a modest evaluation of the Marudi gold mine. Ideally, the corporation's presence at Marudi could start after the third year of its operation - the former two years being concentrated at Groete Creek, after which time the definition of the deposit would have been precise enough to determine the next move. In this way the corporation does not spread itself too thinly.

Based on estimates of exploration cost given by McDame Exploration Limited, and from an assessment of the cost of geological operations, it is assessed that the corporation would require about one million dollars (Guyana) for its first five years of operation.

Assuming that a commercially exploitable deposit is found, then the problem of raising large sums of development finance would have to be tackled. At this stage, the government-via Guymine-would want to consider the alternative sources of finance, and the kinds of agreements into which it will enter. It should of course be obvious that if external partnership is sought, the government's bargaining position is that much more enhanced by its greater knowledge of the deposit's value.

The other course of mineral development envisaged in Guyana is the acquiring of prospection, and eventually production rights by private individuals. Enough emphasis cannot be stressed about the requirements that the terms of conveyance of mineral rights by the state to private persons, and the expression of sovereignty and other national concerns must be consistent, and stable, as instability in property rights is one of the greatest deterrents to the movement of capital. One must always beware of the situation where political attitudes and policies overrule the technical factors of geology and economics, except it is absolutely essential.

The prospects for development in Guyana will be reflected to a large extent by the suitability of its planning procedures. Two basic approaches to planning are:

(i) The simulation of what is required without consideration of its feasibility.

(ii) Analysis of the existing situations and environment, and determining what is most likely to be accomplished. The former approach is that of the idealist, who makes very unrealistic demands on available resources, while requiring an awesome amount of authority to be vested in the state machinery. The latter approach is that of the conservative, whose role does not take as great a toll on the material and human resources of the country, but promotes development in a time frame which may be inconsistent with the material aspirations of peoples living in a milieu of persistent poverty and underdevelopment. Either alternative, rigidly followed, can result in levels of social tension which the economy cannot accommodate.

Somewhere between the two extremes lies the least damaging solution. Planning must have the direction of the idealist, which must be tempered by the realities of the environment. This dissertation is completely guided by this view, and in Chapters 2 to 8, an attempt was made to understand the environment which finally moulds a mineral policy. The national economy, the mineral economy, and the international community were considered as the relevant components of the operative environment.

The national economy was shown to be narrowly based with a large dependence on a few primary commodities, principally sugar, rice and bauxite. Un-and-under employment are at socially unsatisfactory levels, while at the same time there is a paucity of skilled personnel. Capital resources are scarce, and when combined with a stagnating export sector, they have led to a burgeoning external and internal debt.

To counter the above ills, the government has increased actively its presence in the economy, to the point where it is the single largest contributor to income, output and employment. A significant part of the incrase in government involvement is a direct result of the nationalisation of the bauxite and sugar industries which are the principal growth sectors in the economy. Not withstanding the change in the ownership of the production process, the figures do not demonstrate significantly any structural changes in the economy, with respect to meeting the material aspirations of the Guyanese people.

The analysis on development alternatives seems to suggest that small countries, like Guyana, are well placed for rapid development, if they could capture the opportunities afforded by their original resource endowment. Development caused by investing in consumption goods industries was seen to be transitory, because of the large intermediate-goods imports, coupled with the constraints of small size which seemingly mitigates against capturing of the full scale economies. The latter concern has two facets, as ceteris paribus, the capturing of scale economies involves both a quantum and a price advantage, which are so necessary for the export earnings dimension.

Empirical evidence cited in Chapter 3, indicated that the best prospects for growth and development was by the sponsoring of capital goods industries. However, the same constraints of small size which mitigated against a consumption - goods - led industrialisation process is also a severe bottleneck in fostering capital goods development. Secondly, the promotion of capital goods industries presupposes that capital is available, but, of course, this is contrary to the factor endowments of Guyana.

The search for a 'development commodity' - to coin a phrase - seems therefore to be the search for a product which is neither hampered by the local factor proportions, nor constrained by size. Minerals fit that bill.

Minerals are principally international products, being the largest item of world trade. Capital, must of necessity, move to bridge the gap between the locus of consumption and the locus of occurrence, which are invariably different. Therefore, in the context of a surplus labour economy, where capital is scarce, the attracted capital can only complement the prevailing factor proportions. Because minerals are so heavily traded, the size of the nation or immediate economic area ceases to be a constraint on the quantum produced; hence the economies of scale controlled principally by the deposit characteristics, can be fully achieved.

Guyana has an extremely uneven population density problem as depicted in Chapter 2. The carrying capacity of the coastal strip in terms of its ability to permit adequate means of livelihood will become extremely overloaded unless people are encouraged to relocate in the hinterland. However, hinterland development will not occur unless opportunities become available for people to freely relocate to attain their individual and collective aspirations.

Interior development can be considered from the standpoint of the non-shiftable mineral resource endowment, for which the interior has a comparitive advantage. Recognizing the needs for diversification of the economy, and population relocation away from the overpopulated coastal regions, conventional wisdom would indicate that disbursements of the kind which have been traditionally allocated to the mineral sector do not reflect their true potential social value. Rather, it can be argued that the under-representation of societal preferences in this regard must take full responsibility for the obvious stagnation and impasse that currently besets the local economy. It is therefore recommended that greater tangible priority be given to mineral development in Guyana.

The argument for an increased mineral-activity emphasis as a source of development is an indirect one, since it is recognized that mineral development is essentially capital-intensive and hence the potential contribution to a diversified output and employment may be negligible. The rationale for the posit lies principally on the fact that mineral activity offers a relatively greater opportunity for the generation of an economic surplus, which can then be used to diversify the economy in a manner which is consistent with the factor endowments and prevailing needs.

The international aspect of the mineral industry was alluded to in the preceding section, and the role of transnational corporations the principal participants in mineral development came under close scrutiny in Chapter 5. In Chapter 4, it was indicated that as a consequence of the capital intensity of mineral activity, and a number of points raised, the mineral industry was characterized by an oligopolistic market structure, dominated by mega-conglomerates. Consequently the small-nation state endeavouring to participate in the mineral industry must be fully cognizant of the prevailing power relations, and how it could adapt to them. From a consideration of prices, the small nation state-producer might be more of a price-taker, hence much emphasis must be placed on maintaining respectable cost levels.

Apart from the market clearance function, prices were seen to have a redistributive role in the international commodity diplomacy. Guyana must ensure that its long-term future is not jeopardized by transitory lines of allegiance which will not bring much gain to itself. The analysis on cartels and commodity agreements reflect that there are no cartellizable commodities with the impact of oil in the armament of the underdeveloped countries as a group, hence Guyana should ensure that it places more emphasis on its own internal production relations and cost structure, so that it can capitalize on any price increases, which may become available as a result of the dynamics of the international economy. Advocacy for greater wealth redistribution should still be maintained, but Guyana must be cognizant of the real limits to price augmentation in view of the distribution of mineral resources, trade patterns and impact of technology.

Technology was shown to be able to affect the positioning of a given category of resource by either making it uneconomic through provision of substitues, etc.; or by making it economic by discovering newer uses, or methods of treatment. This clearly demonstrates the absolute need for local research.

Guyana is fortunate in having a well educated populace, which regretably is not sufficiently technically skilled. The attempts by the government to counter this deficiency are extremely welcomed changes, and it can auger well for the future. However, the university must start to play a greater role in development problems. The treatment of titaniferous iron ores is certainly a problem which must be solved. The existing world economy of iron would relegate to a relatively low priority, the treatment of the titanium contaminant. This is a research project which can engage the expertise of the university, as success can lead to a really significant contribution to the nation. An iron industry necessarily changes the economics of the manganese deposits which are significant inputs in a combined ferromanganese endeavour.

Given stability in property rights, capital will move to any location where it would receive at least its opportunity income. From the government's standpoint, the resource which it holds in trust for it's citizenry should also obtain its opportunity income. Hence, the principal role of government is to define a path which maximizes its net revenues from mineral exploitation. Among the alternatives considered, a preference for a modified Resource Rent Tax is advocated. It engenders a sense of stability which is so necessary in long-gestation activities like mining. The bottom line is spelled out, and when used in a joint-venture atmosphere, as proposed in Chapter 8, it promotes a greater harmony between company and state, while the latter gains some of the immediate benefits of its resource endowment.

The analysis of the ~~preceding~~ eight chapters has persuaded the author to accept the advisability of a mixed, and diversified economy. Conclusions have therefore been drawn that Guyana needs to entertain a great degree of external partnership if it is to develop at the rates envisioned by the idealists. Guyana is also particularly fortunate to be endowed with a potential for significant mineral development. However, mineral development is only a permissive condition for real material achievements. The true significance of these minerals to development rests squarely on the abilities of its peoples and its institutions to seize, adopt, and transform those opportunities into forms of economic activity which are resilient and self perpetuating.

BIBLIOGRAPHY

ABRAMOVITZ, M., Connections between natural resources and economic growth. J. J. Spengler - Natural Resources and Economic Growth, University of Michigan 9-15, 1960.

ADELMAN, M.A., The world Oil Output. In M. Clawson (Ed.), Natural Resources and International Development, Resources for the future, 27-114, 1964.

ALEXANDER, J. G. W., Geology and Mineralisation of The Honey Camp Area. Guyana Geological Survey Internal Report, 53, 1975.

ALLEN, J. B., Pyroclastic origin of supposed microfossils in the Roraima formation, Guyana. Nature, Vol. 215, 1261-1262, 1967.

ALLEN, P.M., The Geology of the Upper Barama River and an area southwards to the Venezuelan Border. Guyana Geological Surveys Internal Report, PMA 1/63. 20, 1963.

AMAROL, G., RAMGRAB, G.E., OLIVERA, I., MANDETTA, P., and DAMISO, R.N., Geochrological studies and considerations on the Precambrian stratigraphy at the northern part of Roraima Territory. Bo. Espec. Soc. Bras. Geol., No. 1, 77-80, 1970.

ANHAEUSSER, C. R., The geological evolution of the primitive earth: Evidence from the Barbeton Mountain Land. Econ. Geol. Res. Unit, Univ. Witwatersrand, Inf. Circ., Vol. 98, 22, 1975.

ARNOTT, B.M., Report on Aerial Radioactivity Survey E.P.L. No. 1, Guyana. For Denison Mines Limited. Unpublished. 12, 1969.

BAER, A.J., VEIZER, J., and BARAGAR, W., Relationships between Archean granites and greenstones. Geoscience Canada Vol. 5, (1), 1978.

BANERJEE, S. K., Gold mineralisation in the Guyana Shield. Proceedings of the eight Guiana Geological Conference, 24, 1970.

BANERJEE, S. K., Wariri gold project, Cuyuni River. Guyana Geological Surveys Internal Report, R.H. 2/20 4, 1970.

BANERJEE, S.K., FAWCETT, S., and NARAIN, K., 9th Inter Guiana Geological Conference "Molybdenum and Tungsten Mineralisation in the Mahdia Area". Guyana Geological Surveys Internal Report AF 1/72, 14, 1972.

BANERJEE, S.K., and SAHA, S.N., Case History of Exploration over an Airborne EM anomalous zone near Empressa, Upper Dumerara River, Guyana. Proceedings of the eight Guiana Geological Conference, 20, 1970.

BANK OF GUYANA, Annual report 1975.

BARBEY, P., The Adam Talha epizonal sequence (North Mauritania) and a general scheme for the Eburnean orogenic belt of West Africa. Precambrian Res., Vol. 2, 255-262, 1975.

BARD, J.P., and LEMOINE, S., Phases tectoniques superposees dans les metasediments precambriens du domaine cotier occidental de la Cote d Ivoire. Precambian Res., Vol. 3, 209-239, 1976.

BARNETT, H., and MORSE, C., Scarcity and Growth. The economics of natural resource availability, Baltimore, John Hopkins, 288 , 1963.

BARRON, C.N., Brief note on iron ore deposits in the South Savannas. Guyana Geological Survey Int. Report No. CNB 1/60, 4, 1960.

BARRON, C.N., Gold mining in Guyana, 1968. Geol. Survey Department, 1968.

BARRON, C.N., Some features of interest in the geology of the South Repununi Savannas. Proc. 5th Inter-Guiana Geol. Conf., Georgetown, 1959, 113-118, 1961.

BARRON, C.N., The geology of the South Savannas degree square. Bull. Geol. Surv. Br. Guiana, No. 33, 22, 1962.

BARRON, C.N., Notes on the stratigraphy of Guyana. Proceedings of the Seventh Giuana Geological Conference, Parimaribo, 1966, Rec. Geol. Surv. Guyana, Vol. 6, II, 1-28, 1969.

BARRON, C., Summary Report on Peters' Mine Guyana, South America. Guyana Geological Survey Internal Report, CNB 4/72, 19, 1972.

BARRON, C.N., Notes on the Geology of Guyana along the frontier with Venezuela. Guyana Geological Surveys Internal Report, 28, 1975

BARRON, C.N., A further guide to Mineral Exploration in Guyana (Supplement to Bulletin 38) containing notes on fifty of the more interesting prospects brought to light between 1965 and 1969. Proceedings of the eighth Guiana Geological Conference 52, 1970.

BARTHOLOME', P., Gisements stratiformes et provinces cupriferes. Liege, Societe geologique de Belgique 427.

BATESON, J. H., Report on the Geochemical results of an area between the Mariwa and Tupuree Creeks, Cuyuni River. Guyana Geological Surveys Internal Report JHB 5/65, 3, 1965.

BAUMOL, W. J., and OATES, W.E., Conservation of resources and the price system. In R.D. Leiter, and S. L. Friedlander (Eds.), Economics of Resources, Vol. 3, 15-34, 1976.

BEHRENDT, J., SCHLEE, J., ROBB, J., and SILVERSTEIN, M., Structure of the continental margin of Liberia, West Africa. Geol. Soc. of Amer. Bull., Vol. 85, 1143-1158, 1974.

BENNETT, H. J., The Mineral Policy of Selected Foreign Nations considering Direct Foreign Investment in the Mineral Industry. Quarterly of the Colorado School of Mines, Vol. 68, No. 4, 213-259, 1973. Science TN/1/CF2.

BENNETT, W. D., CHAMBERS, A. D., THOMPSON, A.R., EDDY, H.R., and CORDELL, A.J., Essays on aspects of resource policy. Science Council of Canada background study No. 27, 113, 1973.

BERRANGE, J. P., A synopsis of the geology of Southern Guyana. Rep. Photogeol. Unit, Overseas Div., Inst. Geol. Sci., London, No. 26, 16 (Unpublished).

BERRANGE, J. P., The geology of Southern Guyana, South America. Institute of Geological Sciences, London, 1977.

BERRANGE, J. P., The riebeckite granite of Makarapan Mountain. A reinterpretation. Proceedings of the eight Guiana Geological Conference, 13, 1970.

BERRANGE, J. P., Operation El Dorada - A.V.K. - Guyana Photogeological Mapping Project. Proceedings of the eight Guiana Geological Conference, 8, 1970.

BERGER, A.R., (Ed.), Geoscientist and the Third World, A collective coitique of existing aid Programs. Geological Survey of Canada (EMR), 74-57, 1975.

BILIBIN, Y. A., Metallogenic provinces and Metallogenic epochs. Queen's College Press (translated by E. A. Alexandrov), also reproduced in W. Walker ed: Metallogeny and Global tectonics 1976. 1-35, 1968.

BONIS, G., Recommendations for the refocusing of International assistance programs in natural resources. Earth Science Aid to Developing Countries. Symposium 2, 24th Int. Geol; Cong. Montreal. 61-66, 1972.

BLEACKLEY, D., The North Savannas of the Rupununi District Rec. Geol. Surv. Br. Guiana, Vol. 1, 7-20, 1962.

BLONDEL, F., & LASKY, S.G., Mineral reserves and mineral resources. Econ. Geol. Vol. 51, 686-697, 1956.

BOADWAY, R.W., TREDDENICK, J.M., The impact of the mining industries on the Canadian economy. Centre for Resource Studies, Queens' University, Ont. 117, 1977.

BOSMA, W., and GROENEWEG, W., A review of the stratigraphy of Suriname. Proceedings of the eight Guiana Geological Conference, 32, 1970.

BOSSON, R., and VARON, B., The mining industry and the the developing countries. A world bank research publication Oxford University Press, 292, 1977.

BOYLE, R. W., Mineralization processes in archean greenstone and sedimentary belts. Geol. Surv. of Can., Paper 75-15, 1976.

BRACEWELL, S., Euxenite in British Guiana, republished, 7, 1957.

BRACEWELL, S., Report on the geology of the Waikuri District, Cuyuni River. Bull No. 18, Geol. Surv. Br. Guiana, 16, 1942.

BREWSTER, H., Economic dependence: A quantitative interpretation. A special issue of Social and Economic Studies. Institute of Social and Economic Research. Vol. 22, No. 1, 90-95, 1973.

BREWSTER, H., Wage policy issues in an open underdeveloped economy, Institute of Social and Economic Research, Univ. of the West Indies, 1969.

BREWSTER, H., and THOMAS, C.Y., Dynamics of West Indian Integration Studies in Regional Economic Integration. Vol. 1, 335, 1967.

BROOKS, D. B., Mineral supply as a stock. In W.A. Vogeley (Ed.), The economics of the mineral industries AIME, New York, 1975.

BUCK, W.K., and ELVER, R.B., An approach to mineral policy formulation. Mineral information bulletin MR108 Department of Energy, Mines and Resources, Canada 15, 1970.

BURKE, K., and DEWEY, J. F., An outline of Precambrian plate development. In D. Tarling and S. Runcorn (Eds.), Implications of continental drift to the earth sciences. Vol. 2, 1035-1045, Academic Press, London, 1973.

BURKE, K., DEWEY, J.F. and KIDD, W.S.F., Dominance of horizontal movements, Arc and Microcontinental Collisons during the later Permobile Regime. In B. Windley (Ed.), the early history of the earth. Wiley, 1976.

BURNHAM, L.F.S., Breakthrough. Reprint of an address by Prime Minister Burnham before the People's National Congress Convention, 6th May 1973, Georgetown, Guyana.

BURNHAM, L.F.S., A destiny to mould. Selected discources by the Prime Minister of Guyana. Longman Caribbean 275, 1970.

BURNHAM, L.F.S., Control of our natural resources. Address to the nation by the Prime Minister of Guyana on Republic Day, Feb. 23, 1971, Georgetown, 1971.

BURNHAM, L.F.S., Towards a co-operative replubic. Georgetown, Guyana, Peoples National Congress, The Chronicle, 1969.

CAMPBELL, H.F., GAINER, W.D., SCOTT, A., Resource Rent: How much and for Whom? Natural Resource Revenues: A test of Federalism, ed. Anthony Scott. British Columbia Institute for Economic Policy Analysis Sexis, 118-136, 1976.

CANNON, R.T., Classification of Amphibolites, Bull. Geol. Soc. Amer. Vol. 74, 1087-1088, 1963.

CANNON, R. T., A preliminary report on the geology of areas in the lower Barama and Waini Rivers. Guyana Geological Surveys Internal Report RTC 3064, 6 , 1964.

CARMAN, J.S., Limiting factors in foreign development aid with particular reference to mineral exploration. Earth Science Aid to Developing Countries. Symposium 2, 24th Int. Geol. Congress Montreal, 189-196, 1972.

CARTER, J. W., Preliminary report on the geology of the Haimaralli Falls - Aurora Creek area. Geol. Sur. of Guyana Files, 1963.

CARTER, J. W. and FERNANDES, L.L., The stratigraphical, lithological and structural controls to mineralisation within the Barama - Mazaruni Assemblage Rec. Geol. Surv. Guyana, Vol. 6, XII, 1-22, 1969.

CARTER, M. W., Final expedition report Siparuni Burro-Burro watershed, Geological Survey of Guyana Files, 1959.

CARTER, M. W., Notes on Quarter degree sheet 0458 SW. Kurupukari S.W. 1:200,00 geol. Atlas,Br. Guiana, 1962.

CARTER, M. W., The volcanic plutonic relationship in the Northern Rupununi Proc. 5th inter-Guiana Conference, 1959, 129-139, 1961.

CHENERY, H.B., The role of industrialisation in development programes. The economics of underdevelopment. ed: A.N. Agarwala and S.P. Single, Oxford University Press. 450-471, 1958, Reprinted 1971.

CHOUBERT, par B. le Precambrien des Guyanes. Bureau de Recherches Geologiques et Miniers Par. 5, No. 81, 1974.

CHOUDHURI, A., and MILNER, M. W., Basic magmatism in Guiana and continetal drift. Nature, Phys. Sci., London. Vol. 232, 154-155, 1971.

CIRIACY - WANTRUP, S.V., Economics and Policies of Resource Conservation. Natural Resources eds: Huberty and Flock. 500-526, Ch. 19, 1959.

CIRIACY - WANTRUP, S.V., Resource Conservation; Economics and Policies. Revised Edition. University of California Press, 395, 1962. Note: Chapter 3 for Classifications of Resources.

CLARK, R., Development problems of an export economy. The case of Chile and Copper. In Mamalakis and Reynolds, Essays on the Chilean Economy, Yale, 1965.

CONOLLY, J.H.C., Report of the preliminary survey of the Mazaruni and Puruni diamond fields. Georgetown, 1925.

COOPER, R.N., Natural Resources and national security. Resources Policy. Vol. 1, No. 4, 192-203, 1975.

COPES, P., Canadian Fisheries: Economic waste and social Collier-Macmillian Ltd., 1972.

CRANSTON, D.A. and MARTIN, H.C., Are discovery costs increasing? Canadian Mining Journal. Vol. 94, 53-64, 1973.

DALES, J. H., Comment on connections between natural resources and economic growth. J.J. Spengler ed: Natural resources and economic growth. University of Michigan. 16-19, 1960.

DALY, V.T., A short history of the Guyanese People. Macmillan Education Ltd., 326, 1975.

DASGUPTA, A.K., and PEARCE, D.W., Cost-Benefit Analysis: Theory and Practice., Macmillian Student Editions Chapters 6 and 7, 1974 (ed. 1972).

DAVID, W.L., Comprehensive planning for national economic development with a brief review of the Guyana experience. Papers in economics and management. Fisk University, 35, 1975.

DEMAS, W., The Economics of Development in Small Countries. McGill University, 1965.

DERRY, D.R., Exploration Expenditure, Discovery rate and Methods, CIM Bulletin, Vol. 63, No. 695, 362-366, 1970.

DEWITT SMITH AND COMPANY INC., Report on Investigation of Mineral Concessions in Guyana for Ryan Minerals Ltd., Vancouver, B.C. 13, 1969.

DOBB, M., Saving and Investment in a Socialist Economy. Economic Journal XLIX, 713-728, 1949.

DONNERSTAG, P., and ARNOTT, B., Summary Report: Guyana Exclusive Prospecting License No. 1 Denison Mines Limited. Unpublished, 11, 1970.

DOUGAN, T.W., Origin of trondhjemitic biotite - quartz-oligolase gneisses from the Venezuelan Guyana Shield. Precambrian Res. Vol. 3, 317-342, 1976.

DOWD, D.F., Some issues of Economic Development and of Development Economics. Journal of Economic Issues. Vol. 1, No. 3., 149-160, 1967.

DROLET, J., Canadian Mineral policy in an interdependent world. Department of Energy, Mines and Resources Canada. 1974.

DROLET, J., The demand for Canada's mineral resources. Department of Energy, Mines and Resources, Canada. 1974.

DUBLIN, D.S., A report on the Rupununi Limestone (Calcrete) Reconnaissance. Guyana Geological Survey Internal Report 2/72. 6, 1972.

DUBLIN, D.S., Lime - Mud investigations, North Savannas. Guyana Geological Survey Internal Report 1/73. 7, 1973.

DUBLIN, D.S., CAMERON, N.C., Semang report, Guyana Geological Surveys Internal Report, DD 1/72, 23, 1972.

DUESENBERRY, J.S., Income, Savings and the Theory of Consumer behaviour. Cambridge: Harvard University Press. 1949.

ELY, N., Summary of Mining and Petroleium laws of the World. U.S. Bureau Mines Inf. Circ. 8482, part one of five parts, The western hemisphere 159, 1970.

ENGEL, A.E.J. and ENGEL, C.G., Progressive metamorphism and granitisation of the major paragneiss, northwest Adirondack Mountains, New York. Part II: Mineralogy, Bull. Geol. Soc. Am. Vol. 71, 1-58, 1960.

ENGEL, A.E.J., ENGEL, C.G., and HAVENS, R.G., Chemical characteristics of Oceanic Basalts and Upper Mantle. Bull. Geol. Soc. Am. Vol. 76, 719-734, 1965.

ENGINEERING MINING JOURNAL, The going gets bumpy for mining in Latin America. Eng. Mining Journal, Vol. 170, No. 7, 59-60, 1969.

ERICKSON, G.K., Work Commitment Bidding. In M. Crommelin and A.R. Thompson (Eds.), Mineral leasing as an instrument of public policy. The University of British Columbia, Vancouver, 1977.

FAIRCHILD PUBLICATIONS, Metal Statistics: The purchasing guide of the metal industries. American Metal Market, 1976.

FARLEY, R., The unification of British Guiana. Social and Economic Studies 4, 1955.

FERNANDES, L.L., Report on a visit to Matthews Ridge, Northwest District, Guyana Geological Surveys, Internal Report LLF 4/63, 10, 1963.

FERNANDES, L.L., Report on the geological and geochemical prospecting of an area between Aurora and Akaiwong Goldfields, Cuyuni River. Geol. Surv. of Guyana Int. Rept., 1963.

GAFFNEY, M., Editor's Conclusions. Extractive resources and taxation, ed. M. Gaffney, University of Wisconsin Press, 333-419, 1967.

GAFFNEY, M., Objectives of Government Policy in Leasing Mineral lands. In M. Crommelin and A.R. Thompson (Eds.), Mineral leasing as an instrument of public policy. The University of British Columbia Press, Vancouver, 1977.

GAINER, W.D., Rents, Profits and Alternative Divisioning of natural resource revenues in Canada. Prepared for the Victoria Conference on Natural Resource revenues, June 5-7, 1975. (Mimeo).

GAITSKELL, A., Resource Development Among African Countries. Natural Resources and International Development ed. M. Calwson. Resources for the future. 271-305, 1964.

GALBRAITH, J.K., The New Industrial State. Boston, Houghton-Mifflin, 423, 1971.

GANSSER, A., Observations on the Guiana Shield (South America) Eclogae e Geol. Vol. 47, 77-112, 1954,

GARNAUT, R. and ROSS, A., Uncertainty, risk aversion, and the taxing of natural resource projects. Economic Journal. Vol. 85, No. 338, 272-287, 1975.

GARNAUT, R., and ROSS, A., A new tax for natural resource projects. Mineral leasing as an instrument of public policy, M. Crommelin and A. R. Thompson (Eds.), The University of British Columbia, Vancouver, 1977.

GAUDETTE, H.E., HURLEY, P.M., FAIRBAIN, H.W., ESPEJO, A., and DAHLBERG, E.H., Older Guiana basement south of the Imataca Complex in Venezuela, and in Surinam. Geol. Soc. of Am. Bull. Vol. 89, 1290-1294, 1978.

GAUDETTE, H.E., MENDOZA, V., HURLEY, P., and FAIRBAIN, H., Geology and age of the Parguaza rapakivi granite, Venezuela. G.S.A. Bull. Vol. 89, 1335-1340, 1978.

GHANSAM, J., Report on Pipiani Creek. Guyana Geological Surveys. 1970.

GIBBS, A., Barama-Mazaruni Project: Central and Western Barama Belt Geol. Surv. & Mines Dept., Georgetown, Guyana, 1978.

GIBBS, A., Mazaruni - Puruni Experience: The central Puruni section, Geol. Surv. and Mines Dept., Georgetown, Guyana, 1977.

GIBSON, C., A preliminary report on Dickman's Hill molybdenum prospect. Guyana Geol. Surv. Internal Report CG 1/73, 16, 1973.

GIBSON, C., Year end report Guyana Diamonds. McDame Exploration Ltd., 12, 1976.

GILBERT, C.L., The post-war tin agreements: An assessment. Resources Policy, 108-117, 1977.

GIRVAN, N., Corporate Imperialism: Conflict and Expropriation. Transnational corporations and Economic Nationalism in the third world. M.E. Sharpe Inc., White Plains, New York, 1976.

GIRVAN, N., Multinational Corporations and dependent-Underdevelopment in mineral export economies. Social and Economic Studies. Nol. 19, No. 4, 490-526, 1970.

GIRVAN, N., The denationalization of Caribbean bauxite: Alcan in Guyana. New World Quarterly, Vol. 5, No. 3, 35-48, 1971.

GIRVAN, N., The development of Dependency Economics in the Caribbean and Latin America: Review and Comparison. A special issue of Social and Economic Studies. Institute of Social and Economic Research. Vol. 22, No. 1, 1-33, 1973.

GIRVAN, N., The Guyana-Alcan conflict and the Nationalization of Demba. New World Quarterly, Vol. 5 No. 4, 38-49, 1972.

GIRVAN, N., and JEFFERSON, O., Corporate vs Caribbean Integration. New World Quarterly, Vol. 4, No. 2, 45-56, 1968.

GLIKSON, A., Discussion, a major unconformity in the Archaean Jones Creek, Western Australia, J. of Geol. Soc. Aus. No. 19, 251, 1973.

GLIKSON, A.Y., Earliest precambrian ultramafic - mafic volcanic rocks: Ancient Oceanic crust or relic Terrestorial Maria? Geology, 4, 201-205, 1976.

GLIKSON, A.Y., Relations in space and time between major precambrian shield units: An interpretation of Western Australia data. Earth and Planetary Science Letters, No. 20, 395-403, 1973.

GORDON, H.S., The economic theory of a common property resource: The fishery. Journal of Political Economy, Vol. 62, No. 2, 124-142, 1954.

GOVERNMENT OF GUYANA, Annual account relating to external trade. Statistical Bureau, Ministry of Economic Development, Various years.

GOVERNMENT OF GUYANA, Annual Statistical Abstract. Statistical Bureau, Ministry of Economic Development, Various years.

GOVERNMENT OF GUYANA, Guyana in brief. Guyana Information Services, 95, 1976.

GOVERNMENT OF GUYANA, The laws of Guyana. Mining Act. Chapter 65: 01, 1973.

GOVERNMENT OF GUYANA, Quarterly review of financial statistics. Statistical Bureau, Ministry of Economic Development, Various issues.

GOVETT, G.J.S., The development of geochemical exploration methods and techniques. Mineral Supplies of the world ed. G.J.S. Govett and M. H. Govett. Chapter 11, 343-371.

GOVETT, G.J.S. and GOVETT, M.H., The concept and measurement of mineral reserves and resources. Resour. Policy, Vol. 1, 46-55, 1974.

GOVETT, G.J.S. and GOVETT, M.H., The inequality of the distribution of world mineral supplies. Can. Inst. Min. Met. Bulletin. Vol. 70, No. 784, 59-71, 1977.

GOVETT, G.J.S. and GOVETT, M. H., New directions for development aid in the earth science. Earth Science Aid to Developing Countries. Symposium 2, 24th Int. Geol. Cong., Montreal. 203-211, 1972.

GOVETT, G.J.S., and GOVETT, M.H., World Mineral Supplies: assessment and perspective. Elsevier Scientific, New York, 1976.

GRANT, C., Company towns in the Caribbean: A preliminary analysis of Christianburg, Wismar - McKenzie, Caribbean Studies, Vol. 2, No. 2, 1971.

GRAY, L.C., Rent under the Assumption of Exhaustibility. Reprinted in M. Gaffney ed. Extractive resources and taxation., 423-446, 1967.

GREEN, L.C., Sovereignty, resources and the law of the sea. In foremost nation: Canadian foreign policy and a changing world. Edited by N. Hillmer and G. Stevenson, Chaper 6, 126-149, 1977.

GROSS, G.A., An examination of the iron ore potential in British Guiana. United Nations technical assistance board. MRD Report 161 in Geological Survey Files, 1962.

GRUNWALD, J., Resource aspects of Latin American economic development. Natural resources in international development. ed. M. Clawson, Resources for the Future, 307-338, 1964.

GUARDIA, F. J. L., The Omai Mine Area Report on Geological and Geochemical Surveys. Guyana Geol. Surveys Internal Report, FJL; 1/69, 47, 1967.

GUARDIA, F. J. L., Report on geolocial and geochemical surveys in the Omai Mine Area. Guyana Geological Surveys Internal Report, 47, 1967.

GUARDIA, F. J. L., Report on the investigation of the Itaki Hills magnetic anomaly. Guyana Geological Report 1/67, 28, 1967.

GUYANA BAUXITE COMPANY Ltd., Annual Report and Accounts 1975.

GUYANA GEOLOGICAL SURVEYS, Annual Reports (various years).

HAMILTON, M.C., Further progress report on the Groete Creek gold - copper prospect. Guyana Geological Surveys Internal Report MH 1/68, 40, 1968.

HAMILTON, M.C., Geochemistry and geo-physics as indicators of economic mineralisation in the Groete Creek area. Proceedings of the eight Guiana Geological Conference, 24, 1970.

HARRIS, D.P., FREYMAN, A.J., and BARRY, G., The methodology employed to estimate potential mineral supply of the Canadian North West. Min. Inf. Bull. MR 105, 1-56, 1970.

HAWKES, D.D., An area between the Mazaruni and Upper Puruni rivers. A Rep. Geol. Surv. Br. Guiana, 1960, 52-52, 1961.

HAWKES, D.D., Differentiation of the Tumatumari - Kopinang dolerite intrusion, British Guiana. Geol. Soc. of Am. Bull. Vol. 77, 1131-1158, 1966.

HERFINDAHL, O.C., Depletion and Economic Theory. Extractive resources and taxation ed. Mason Gaffney, University of Wisconsin Press, 63-90,1967.

HERFINDAHL, O.C., and KNEESE, A.V., Economic Theory of Natural Resources. Resources for the Future Inc. 405, 1974.

HEWINS, R.H., Report on the Mariwa-Groete Creek expedition. Guyana Geological Surveys Internal Report RH 1/64, 17, 1964.

HJORLEIFSON, G.R., A national minerals policy. Resources Policy. 37-45, 1976.

HOGAN, J. D., Resource exploitation and optimum tax policies: A control model approach. Extractive resources and taxation ed. M. Gaffney, University of Wisconsin Press, 91-108, 1967.

HOLTROP, J.C.; Information on the grantoid rocks of Suriname, South America. Geol. Soc. Bull. Vol. 80, 2237-2252, 1969.

HOOD, P., and TYL, I., Residual magnetic anomaly map of Guyana and its regional interpretation. Latin American Geol. Congress; 2nd Caracas Proceedings. 1973.

HOPE, K.R., Taxation in developing countries. A case appraisal of Guyana. Bulletin for international fiscal documentation 31, 493-499, 1977.

HOPE, K.R., The political economy of development in post-war Guyana. In Press. 326, 1976.

HOPE, K.R., The post-war external trade of Guyana. Economia Internazionale Vol. 28, 1975.

HOPE, K.R., The post-war planning experience in Guyana. Center for Latin American Studies. Special studies No. 16, Arizona State University, 43, 1978.

HOPE, K.R., DAVID, W.L., and ARMSTRONG, A., Guyans's second development plan 1972-76. A macro-economic assessment. World development Vol. 4, No. 2, 131-141, 1976.

HOTELLING, H., The economics of Exhaustible resources. Journal of Political Economy. 137-175, 1931.

HURLEY, P.M., FAIRBAIRN, H.W., and GAUDETTE, H.E., Progress report on early Archean rocks in Liberia, Sierra Leone, and Guyana, and their general stratigraphic setting. In B.F. Windley (Ed.), The early history of the earth, Wiley, 511-521, 1976.

HUTCHINSON, R.W., Volcanogenic sulfide deposits and their metalogenic significance. Econ. Geol. Vol. 68, No. 8, 1223-1246. 1973.

INASI, J., The geology, mineralisation and associated features of the Eagle Mountain Prospect. Potaro District Guyana. Unpublished Masters Thesis, University of New Brunswick, 1976.

INASI, J., Personal Communication, June 1978.

INFORMATION CANADA, Towards a Mineral Policy for Canada: Opportunities for choice, 24, 1974.

JENKINS, G., Comment. In M. Crommelin & A. R. Thompson (Eds.), Mineral Leasing as an instrument of public policy. The University of British Columbia, Vancouver, 1977.

KALLIOKOSKI, J., Geology of north - central Guyana Shield, Venezuela, Bull. Geol. Soc. Am. Vol. 76, 1027-1050, 1965.

KANASEWICH, E.R., Precambrian rift: Genesis of strat-abound ore deposits. Science, Vol. 161, 1002-1005, 1968.

KEATS, W., The lower Roraima Formation in Guyana in 9th Interguyana Geol. Conference Report. 1974.

KEATS, W., The Roraima Formation Project 1971-1973. Final Report: Georgetown, Guyana Geol. Survey and Mines Department, 1973.

KILINC, I.A., Experimental study of partial melting of crustal rocks and the formation of migmatites. Proc. 24th Int. Geol. Congression, Vol. 2, 109-113, 1972.

KINDLEBERGER, C.P., Terms of trade for primary products In M. Clawson (Ed.), Natural resources in international development. Resources for the Future. 339-365, 1964.

KNIGHT, H.G., The law of the Sea: Cases, documents and readings. Louisana State University law centre: Nautilius Press.Library of Congress Catalogue #75-13974, 1975.

KOVACK, A., FAIRBAIN, H.W., HURLEY, P., BASEI, M. A. S., and CORDANI, U.G., Reconnaissance geochronology of basement rocks from the Amazonas and Maranhao basins in Brazil. Precamb. Res. Vol. 3, 471-480, 1976.

KRONER, A., The precambrian geotectonic evolution of Africa: Plate accretion versus plate destruction. Precamb. Res., Vol. 4, 163-213, 1977.

KRUGER, F.C., Environment, structure, and organization of the mineral industry in W.A. Vogley ed. Economics of the mineral industries 3rd Edition 403-419, 1976.

KRUGER, G. B., Mineral Reserves - A generator of economic growth, in Cento Symposium on development and utilization of mineral resources. Karachi, 1968.

KRUGER, F.G., Mining - A business for Professionals only. Mining Engineer. P. 83-88, 1969.

KUZNETS, S., Economic growth of small nations. In E.A.G. Robinson (Ed.), Economic consequences of the size of nations, 14-34, 1960.

KUZNETS, S., Underdeveloped countries and the pre-industrial phase in the advanced countries. In A. N. Agarwala and S.P. Singh (Eds.), The economics of underdevelopment. Oxford University Press, 135-153, 1958: Reprinted 1971.

LAFITTE, P., Cartographie metallogenique et gites stratiformes: Un metallotecte epicontinental. In J.S. Brown (Ed.), Genesis of stratiform lead - zinc - barite - flourite deposits. Econ. Geol. Monograph. Vol. 3, 227-233, 1967.

LAMING, D.J.C., and AJAKAIYE, D.E., (Eds.), New directions in mineral development policies. Association of Geoscientists for Inter. Devpt. 1977.

LEITH, C.K., Mineral valuations of the future, In C.K. Leith (Chairman), Elements of a national mineral policy. AIME, New York, 47-48, 1938.

LEVITT, K., Canada: Economic dependance and political disintegration. New World Quarterly. Vol. 4, No. 2, 57-139, 1968.

LEVITT, K., Silent surrender: The Multinational Corporation in Canada. McMillan, Toronto, 1970.

LEWIS, A.W., Economic development with limited supplies of labour. In A.N. Agarvala and S.P. Singh (Eds.), The economics of underdevelopment Oxford University Press, 400-449, 1958.

LEWIS, T., Monopoly exploitation of an exhaustive resource. Journal of Environmental Economics and Management. Vol. 3, 198-204, 1976.

LONCKE, J.V., The Honeycamp Experience. A report on experiments carried out at Honeycamp; 2nd field season, 1973.

LOVERING, T., Mineral resources from the land. Resources and Man. A study of the Committee on Resources and Man. National Academy of Sciences, San Francisco. W.H. Freeman and Co., 109-134, 1969.

MALTHUS, T., An Essay on Population. 2 Volumes, New York Dutton, 1958.

MARTIN, D., Resource Control and Market Power. In M. Gaffney (Ed.), Extractive resources and Taxation. Univerisity of Winsconsin Press, 119-138, 1967.

MATTHEWS, P.F.P., Report on the geological reconnassance survey for iron ore between the Barima and Barama rivers and on detailed mapping near Arakaka with reference to manganese deposits. A Rep. Geol. Sur. Br. Guiana, 85-97, 1951.

MEAD, W.J., Cash bonus bidding for mineral resources. In M. Crommelin and A.R. Thompson (Eds.), Mineral leasing as an instrument of public policy. The University of British Columbia, Vancouver, 1977.

MEAD, J., Resource control as a basis for market power. The case of timber. In M. Gaffney (Ed.), Extractive resources and taxation, University of Wisconsin Press. 139-156, 1967.

MEADOWS, D.H., MEADOWS, D.L., RANDERS, J., BEHRENS, W.W., The Limits to Growth, New York Universe Books, 1972.

MIKESELL, F., Financial Considerations in Negotiating Mining Development Agreements., Mining Magazine. April 1974.

MIKESELL, R., Foreign Investment in Copper Mining. Case Studies of Mines in Peru and Papua New Guinea. Published for Resources for the Future Inc. John Hopkins University Press, 1975.

MIKESELL, R., Financial considerations in negotiating mining development agreements. In Negotiating and Draftings of Mining development agreements. Mining Journal Books, London, 17-20, 1976.

MIKESELL, R., Rate of Exploitation of Exhaustible Resources. The case of an Export Economy. Natural Resources Forum, Vol. 1, No. 1, 39-46, 1976.

MINING JOURNAL, Inducements to Mine. London Mining Journal, Vol. 272, No. 6972, 273-274, 1969.

MINING JOURNAL, Mining annual review, 1977.

MINING JOURNAL, Latin America perspective. London Mining Journal, Vol. 276, No. 7069, 77-79, 1971.

MOHR, D.M., Economic development strategies and foreign ownership policies of selected countries. Mineral Bull, M R 126, Dep. Energy, Mines and Resources, Ottawa, 49, 1972.

MORRIS, P.I., Geological reconnaissance of Makarapan and parts of the Essequibo, Rewa and Rupununi Rivers. A Rep. Geol. Surv. Guiana, 1958, 33-34, 1959.

MORRIS, P.I., The geology of the western Kanuku Mountains and the adjacent area. Rec. Geol. Surv. Br. Guiana, Vol. 1, 43-48, 1962.

MORRISSETT, I., Economic Theory and Resource Policy. In M. Gaffney (Ed.), Extractive resources and taxation. University of Wisconsin Press, 295-314, 1967.

MORSE, C., Potentials and hazards of direct international investment in raw materials. In M. Clawson (Ed.), Natural resources and international development. Resources for the future, 369-414, 1964.

MORTON, R.D., Types of Uranium deposits. Mimeograph, 1978.

MYINT, H. (1954) An interpretation of economic backwardness. In A.N. Argawala and S.P. Singh (Eds.), Oxford University Press, 93-134, 1958, Reprinted 1971.

MACDONALD, J.R., A guide to mineral exploration in Guyana. Bull. Geol. Surv. Guyana. No. 38, 91, 1968.

MCCANDLESS, G.C., Reconnaissance geology of the northwest region of the state of Bolivar, Venezuela. Caribb. J. Sci., Vol. 2, 145-155, 1962.

MCCASKILL, J.C., Keynote Address, Cento symposium on development and utilization of mineral resources. Karachi, Pakistan, 1968.

MCCASKILL, J.C., Minerals and International Trade. in W.A. Vogely (ed.), Economics of the mineral industries, 3rd Edition, 73-107, 1976.

MCCONNELL, R.B., Notes on the erosion bevels and geomorphology of British Guiana. Guyana Geological Surveys Internal Report, RBM 1/62 12, 1962.

MCCONNELL, R.R., Provisional geological map of British Guiana. 1: 1,000,000. (Georgetown: Geological Survey of British Guiana), 1962.

MCCONNELL, R.B., and WILLIAMS, E., Distribution and provisional correlation of the Precambrian of The Guiana Shield. Proceedings of the eight Guyana Geological Conference, 22, 1970.

MCCONNELL, R.B., WILLIAMS, E., CANNON, R.T., and SNELLING, N.J., A new interpretation of the geology of British Guiana. Nature. London, Vol. 204, 115-118, 1964.

MCDAME EXPLORATION LTD., N.P.L., Year end report - Guyana diamonds November 1974 - December 1975, 1976.

MCDIVITT, J.F., and JEFFREY, W.G., Minerals and the developing economies in W.A. Vogley (Ed.), Economics of the Mineral Industries, 3rd Edition 3-32.

MCDONALD, S.L., Percentage depletion, expensing of intangibles, and petroleum conservation. In M. Gaffney (Ed.), Extractive resources and taxation. University of Wisconsin Press, 269-288, 1967.

MCINTYRE, A., and WATSON, B., Studies in foreign investment in the Commonwealth Caribbean No. 1. Trinidad and Tobago Part 1. Theoretical Analysis. In R. McDonald (Ed.), The Caribbean Economies 170-185, 1972.

MCKELVY, V.E., Mineral resource estimates and public policy. Am. Sci. Vol. 60, 32-40, 1972.

MCKENZIE, G., The oil cartel and international financial stability. Resources Policy. Vol. 2, No. 2, 107-117, 1976.

NASH, G. and PEARCE, G.H.K., The concept of reserves expanded, CIM forum. CIM Bulletin Vol. 69, No.776 15-18, 1976.

NORDHAUS, W.D., and TOBIN, J., Is Growth Obsolete? NBER fiftieth anniversary Collequium V. Economic Growth, 1972.

NORDHAUS, W.D., Resources as a constraint on growth. American Economic Association. Vol. 64, No. 2, 1974.

NURKSE, R., Some international aspects of the problem of economic development. In A.N. Agarwala and S.P. Singh (Eds.), The economics of underdevelopment. Oxford University Press. 256-271, 1958.

PAGE, W., Mining and Development. Are they compatible in South America? Resources Policy, 235, 1976.

PAUL, T.A., Report on Study of Teperu Quarry. Guyana Bauxite Company Report, 1976.

PEREIRA, J., Further relections on ore genesis and exploration. Mining Mag., Vol. 109, 265-280, 1963.

PERSAUD, T., Conflicts between multinational corporations and less developed countries. The case of bauxite in the Caribbean with special reference to Guyana. Phd. Thesis. Texas Tech. University, 1976.

PETERSON, F.M., An economic theory of mineral leasing. In M. Crommelin and A.R. Thompson (Eds.), Mineral leasing as an instrument of public policy. The University of British Columbia Press, Vancouver, 1977.

PETERSON, F.M., The government role in mineral exploration In M. Crommelin and A.R. Thompson (Eds.), Mineral leasing as an instrument of public policy. The University of British Columbia, Vancouver, 1977.

PINTO, A., and KNAKAL, J., The centre - periphery system twenty years later. A special issue of Social and Economic Studies. Institute of Social and Economic Research. Vol. 22, No. 1, 34-89, 1973.

POSADAS, V.G. and KALLIOKOSKI, J., Rb-Sr ages of the Encrucijada granite intrusive in the Imataca Complex, Venezuela. Earth Planet, Sci. Letters 2, 210-214, 1967.

PRAIN, R.L., State control in the free world copper industry. Trans Ins. Min. Met. 82A, 69-76, 1973.

PREBISCH, R., The economic development of Latin America and its principal problems. Un, Economic Commission for Latin America New York, 1950.

PRIEM, H. N.A., Isotopic geochronology in Suriname Guiana Proceedings of the eight geological Conference 32, 1970.

PRIEM, H.N.A., BOELRJK, N.A., HEBEDA, E.H., VERDURMEN, E.A., and VERSCHURE, R.H., Age of the Precambian Roraima formation in northeastern South America: Evidence from isotopic dating of Roraima pyroclastic volcanic rocks in Suriname. Bull. Geol. Amer. Vol. 84, 1677-1684, 1973.

PUNWASSEE, J.D., Geochemistry in Guyana, 1962-1968. Proceedings of the eight Guiana Geological Conference., 36, 1970.

RADETZKI, M., Mineral commodity stabilisation: The Producers View. Resources Policy, 118-126, 1977.

RAO, V.R., Investment, income and the multiplier in an underdeveloped economy. In A. N. Agarwala and S.P. Singh (Eds.), The economics of underdevelopement, 205-218, 1958.

RAYNOLDS, D.R., Rapid development in small economies. The example of El Savador, New York, Praeger, 124, 1967.

REID, S., Proposed origin for Guyana Diamonds. Geology, 67-68, 1974.

REIMER, H., Rates of return in the mining industry. Can. Inst. Min. Met. Vol. 70, No. 785, 101-105, 1977.

RIDGE, T.D., Emerging nations, their politics and economics and the future of mineral supplies. J. Metals. Vol. 25, 24-29, 1973.

ROBERTS, R.G., The geology of Mattagami Lake mine - Golinee Township, Quebec. Unpublished, Ph. D. Thesis, McGill University, Montreal, 1966.

ROBERTS, W., Mine taxation in developing countries. In M. Gaffney (Ed.), Extractive resources and Taxation. University of Wisconsin Press. 197-218, 1967.

ROBINSON, E.A.G., (Ed.), Economic Consequences of the Size of Nations. Proceedings for a conference held by the International Economic Association St. Martin's Press Inc., 1960.

ROGERS, C., Agreement about commodity agreements? Resources Policy, Vol. 2, No. 2, 73-86, 1976.

ROSCOE, W.E., Probability of an exploration discovery in Canada. Canadian Inst. of Min. Met. Bull. Vol. 64, No. 707, 134-137, 1971.

ROSENBERG, N., Innovative responses to materials shortage. American Economic Review LXIII, 111-118, 1973.

ROSENSTEIN, R.P.N., Problems of industrialisation of eastern and south-eastern Europe. In A.N. Agarwala and S.P. Singh (Eds.), The economics of underdevelopment, Oxford University Press, 245-255, 1958, Reprinted 1971.

ROSTOW, W.W., The take off into self-sustained growth In A.N. Ararwala and S.P. Singh (Eds.), The Economics of Underdevelopment. Oxford University Press, 154-188, 1958.

RUNDLE, C.C., SNELLING, N.J. and CHAN, K.P. Age determinations from southern Guyana. Rep. Geochem. Div., Inst. Geol. Sci., London. No. 72/8, 3, Unpublished.

RUTLAND, R.W.R., Tectonic evolution of the continental crust of Australia. In D. Tarling and S. Runcorn (Eds.), Implications of continental draft to the earth sciences, Vol. 2, Academic Press, Longdon, 1973.

SAHA, S.N., Application of ground geophysics in the search for mineral deposits in Guyana. Proceedings of the eight Guiana Geological Conference, 44, 1970.

SALVATORE, S., SINGER, H., Perspectives of economic development. Houghton Mifflin Company, Boston 1970.

SAMPSON, G., Iron deposits in Guyana. Geological Survey of Guyana Mineral Resources Pamphlet. No. 13 13, 1968.

SAMPSON, G., Preliminary report on further work around Wariri Mine. Guyana Geological Surveys Internal Report RH 1/69, 9, 1965.

SANGSTER, D.F., Precambrian volcanogenic massive sulfide deposits in Canada. Geological Survey of Canada Paper 72-22, 1972

SCHIELLY, H., Preliminary report on the availability of stone for road building construction and sea defences. Government of Guyana. Geological Surveys Internal Report, 15, 1968.

SCHONBERGER, H., and De ROEVER, E.W.F., Possible origin of Diamonds in the Guyana Shield: Comment, Forum Geology, 474-475, 1974.

SCHRAMM, G., Resource - Industry problem. In L. Officer and L. Smith (Eds)., Issues in Canadian economics McGraw Hill, Toronto, 116-134, 1970.

SCHULTZ, T.W., Connections between natural resources and economic growth. In J.J. Spengler (Ed.), Natural Resources and economic growth, University of Michigan. 1-9, 1960.

SCHUMPETER, J., The theory of economic development. Cambridge, Mass. Harvard University, 1949.

SCOTT, A., Natural resources: The economics of Conservation. The Carleton Library, 313, 1973.

SCOTT, A., Notes on User Cost, Economic Journal, Vol. 63, 368-384, 1953.

SCOTT, A., Who should get Natural Resource Revenues. In A. Scott (Ed.), Natural Resource Revenues: A test of Federalism, British Columbia Institute for Economic policy analysis Series. 1-51, 1976.

SEAGRAVES, A., A functional distribution theory and analysis of returns from commodity programs for tobacco and oil. In M. Gaffney (Ed.), Extractive resources and taxation University of Wisconsin Press, 11-24, 1967.

SEERS, D., The mechanism of an open petroleum economy. Social and Economic Studies, Trinidad and Tobago, 1964.

SEERS, D., A model of comparative rates of growth in the world economy. Economic Journal, LXXII, No. 285, 45-78, 1962.

SEERS, D., Big companies and small countries. A practical Proposal. Kyklos, Vol. 16, 599-608, 1963.

SHACKLETON, R.M., Shallow and deep level exposures of Archaean crust in India and Africa. In B.F. Windley (Ed.), the early history of the earth, Wiley, 317-321, 1976.

SHATALOV, Y.T., Some suggestions concerning the principles of classification of ore bearing areas. (Translated by E.A. Alexandrov). International Geology Review, Vol. 6, No. 12, 2110-2126, 1961.

SINGER, H., The distribution of gains between investing and borrowing countries. Papers and Proceedings of the American Economic Association (Supplement to American Economic Review). 473-485, 1956.

SINGH, S., Geology and petrology of part of the Guiana Shield in the South Savanna - Rewa area of Guiana. Bull. Geol. Surv. Guyana No. 37, 127, 1966.

SINGH, S., Preliminary results of exploration drilling and geochemical prospecting at Yakishuru Hill and Ianna Barama River in the North West District. Guyana Geological Surveys Internal Report RH 1/68 9, 1968.

SINGH, S., The international dialogue on commodities Resources Policy. Vol. 2, No. 2, 87-96, 1976.

SKINNER, B.F., A second iron-age ahead. American Scientist, Vol. 64, No. 3, 258-269, 1976.

SNELLING, N. J., and BERRANGE, J.P., The geochronology of Guyana II. Proceedings of the eight Guiana Geological Conference, 20, 1970.

SPOONER, C.M., BERRANGE, J.P., and FAIRBAIN, H.W., Rb-Sr whole-rock age of the Kanuku Complex, Guyana Bull. Geol. Soc. Am. Vol. 82, 207-210, 1971.

STAHL, J.E., Aggregate impacts of the mineral industry on the Canadian economy. Paper presented at the Seventh Annual meeting of the Canadian Economics Association, Kingston, Ontario, 1973.

STANTON, R.L., Ore Petrology, McGraw-Hill, London, 1972.

STEELE, H., Natural Resource Taxation: Resource allocation and distribution implications. In M. Gaffney (Ed.), Extractive Resources and Taxation, University of Wisconsin Press, 233-268, 1967.

STEIGER, R., Preliminary report on the geology and chemistry of an area south of Monkey Falls, Barima River. Guyana Geological Surveys Internal Report RS 2/67, 15, 1967.

STEPHENSON, B., Colluvial gold deposits at Honeycamp, Central Guyana. Guyana Geological Survey Internal Report, 1/71, 630-638, 1971.

STREETEN, P., The dynamics of the new poor power. Resources Policy, Vol. 2, No. 2, 73-86, 1976.

SUNKEL, O., Transnational capitalism and national disintegration in Latin America. A special issue of Social and Economic Studies. Institute of Social and Economic Research. Vol. 22, No. 1, 132-176, 1973.

SUTTON, J., Some changes in continental structure since early precambrian time. In D. Tarling and S. Runcorn (Eds.), Implications of continental drift to the earth sciences. Vol. 2, Academic Press, London, 1973.

SUTTON, J., Some consequences of horizontal displacements in the precambrian. Tectonophysics, Vol. 40, 161-181, 1977.

SVENNILSON, I., The concept of the nation and its relevance to economic analysis. In E.A.G. Robinson (Ed.), Economic Consequence of the size of Nations, 1-13, 1960.

TAKEUCHI, K., Cipec and the copper export earnings of Member countries. The Developing Economies. Vol. 10, 1, 1972.

TAKEUCHI, K., THIETACH, G., and HILMY, J., Investment requirements in the nonfuel mineral sector in the developing countries. Natural resources Forum, Vol. 1, No. 3, 1977.

TANNER, J., Conference Report, UNCTAD4, 3-28 May, 1976 Nairobi, Kenya. Resources Policy, Vol. 2, No.3, 210-213, 1976.

THOMAS, C.Y., Dependence and transformation, the economics of the transition to socialism. New York. Monthly Review Press. 327, 1974.

THOMAS, C.Y., Sugar economics in a colonial situation (The Sugar Industry of Guyana). Studies in Explortation, No. 1, Ratoon, 1970.

THOMPSON, A.R., Natural resource revenue sharing. A dissenting view. In A. Scott (Ed.), Natural Resource Revenues: A test of Federalism. University of British Columbia Press, 112-117, 1976.

TILTON, J. E., The continuing debate over the exhaustion of nonfuel mineral resources. Natural Resources Forum, Vol. 1, No. 2, 167-173, 1977.

TUSSING, A.R., and ERICKSON, G.K., Mining and public policy in Alaska. University of Alaska, SEG No. 21, 1969.

UNITED NATIONS, The acquisition of technology from multinational corporations by developing countries. Economic and Social Affairs Development, (ST/ESA/12), New York, 1974.

UNITED NATIONS, The impact of multinational corporations on development and on international relations. Technical papers: Taxation (ST/ESA/11), New York, 1974.

UNITED NATIONS, An integrated programme for commodities: Specific proposals for decision and action by governments. (TD/B/C11/193). UNCTAD, 1975.

UNITED NATIONS, A Latin American plan of action for the application of Science and Technology to development. U.N. Economic Commission for Latin America, Santiago. E/CN12/966, 245, 1973.

UNITED NATIONS, Measures to expand processing of Primary Commodities in developing Countries. (TD/B/C17/197). UNCTAD, Dec. 1975.

UNITED NATIONS, Mineral resources development with particular reference to the developing countries. U.N. Dept. of Economics and Social Affairs, New York, ST/ECA/123, 1970.

UNITED NATIONS, Multilateral Trade Negotiations. General Assembly (E/AC62/14/No.1), Aug. 1975.

UNITED NATIONS, Multinational corporations in world development. Dept. of Social and Economic Affairs (ST/ECA/190): Sales #E73:II A.11 195, 1973.

UNITED NATIONS, Natural resources of developing countries; investigation, development and national utilization. U.N. Dept. of Economics and Social Affairs, New York, ST/ECA/122, 174, 1970.

UNITED NATIONS, Non-ferrous metals: A survey of their production and potential in the developing countries. UNIDO, New York, E. 72 I I B 18, 188, 1972.

UNITED NATIONS, Report first session, March 17-28, 1975. Commission on Transnational Corporations (12 E/ 5655, EC. 10/6) New York, 1975.

UNITED NATIONS, Small scale mining in the developing countries. U.N. New York, ST/ECA/155, 171, 1972.

UNCTAD, Conference Report, UNCTAD 4, Nairobi, Kenya, 1976.

UNITED NATIONS DEVELOPMENT PROGRAMME, Aerial geophysical Survey of Guyana. DP/SF/UN/4 - Guyana 1968.

U.S. DEPARTMENT OF THE INTERIOR, Mineral Facts and Problems Bureau of Mines Bulletin 650, 1970.

VALLANCE, G., Investigation of a nickelferous "Laterite" in the Kauramembo Mountains (Wanamu - Blue Mountains Area), Barama River, North West District Guyana. Proceedings of the eight Guiana Geological Conference, 18, 1970.

VAN DER HAMMEN, T., and BURGER, D., Pollen flora and age of the Takutu Formation (Guyana). Leidse Geol. Meded., Deel 38, 173-180, 1966.

VAN RENSBURG, W., Reserves as a leading indicator to future mineral production. Resources Policy, Vol. No. 6, 343-356, 1975.

VINER, J., The economics of development. The economics of underdevelopment Ed., A.N. Argawala and S.P. Singh, Oxford University Press, 9-31, 1958.

VINING, J., Guyana, in A. Taylor ed. Focus. The American Geographical Society. New York, 1968.

WAELDE, T.W., Lifting the veil from Transnational mineral contracts: A review of the Literature Natural Resources Forum, Vol. 1, No. 3, 277-284, 1977.

WALKER, R.R., MATERLICH, A., AMOS, A.C., WATKINS, J.J., and MANNARD, G.W., The geology of the Kidd Creek Mine. Econ. Geol. Vol. 7-, 80-89, 1975.

WALLICH, H.C., Some notes towards a theory of derived development. In A.N. Agarwala and S.P. Singh (Eds.), The economics of underdevelopment, Oxford Univ., New York, 1972.

WALROND, G.W., Report on the Rupununi Magnesite occurrences. Guyana Geological Surveys Internal Report, 1975.

WALROND, G.W., Is scarcity of natural resources impeding economic growth? Can. Inst. Min. Mett. Vol. 69, No. 772, 114-119, 1977.

WALROND, G.W. and MORTON, R.D., Manganese nodules: The economics and legal issues. Can. Inst. Min. Met. In Press.

WALROND, G.W., MORTON, R.D., Reflections on the expanded reserves concept. Can Inst. Min. Met. (CIM forum) Vol. 70, No. 789, 17-21, 1977.

WALROND, G.W. & MORTON, R.D., The reserves problem - Further critique of Nash - Pearse Approach Can. Inst. Min. Met. Vol. 71, No. 791, 21-22, 1978.

WATERSTON, A., Resolving the three-horned planning dilemma. In V.R. McDonald (Ed.), The Caribbean Economics. 115-127, 1972.

WEBBER, B.N. Manganese deposits in the North West District, B.G. Geol. Surv. of B.G. Bull.No. 23, 1952.

WEIHRAUCH, F., Geological Exploration in the Cooperative Republic of Guyana. Memorandum: Ministry of Energy and Natural Resources, Geological Surveys Department. 13, 1976.

WEISSENBORN, S., An appraisal of the mineral potential of the Peter's Mine Area, Northwest District, Guyana. U.S.G.S. Internal Report, 20, 1966.

WENDEL, C.A., The discovery - development barrier in the mineral industry. In Cento-symposium on development and utilization of mineral resources. Karachi, Pakistan, 67-81, 1968.

WESTERMAN, S.R., A structural analysis of Matthews Ridge. Proceedings of the eight Guiana Geological Conference. 32, 1970.

WESTERMAN, A.R., Matthews Ridge Manganese Mine N.W.D., Guyana and its environment. Guyana Geological Surveys Internal report 1969.

WICHERTS, E., Interpretation of the geology of the Takutu Basin, Rupununi, British Guiana, Rep. U.N. Tech. Assist. Programme, 13, 1965.

WILCOX, C., Competition and monopoly in American industry. Temporary National Economic Committee Monograph No. 21, Washington, D.C. U.S. Government Printing Office, 1940.

WILKINSON, B.W., Canada's international trade: An Analysis of recent trends and patterns. Private planning association of Canada, Montreal, 1968.

WILLIAMS, E., Traverses of the North-west and Mazaruni Potaro Districts. A Rep. Geol. Surv. Br. Guiana 1960, 40-44, 1961.

WILLIAMS, E., and CANNON, R.T., Report on a visit to Venezuela. Geol. Surv. British Guiana Ann. Report, 1961, 29-30, 1964.

WILLIAMS, E., CANNON, R.T., and McCONNELL, R.B., The folded Precambrian of northern Guyana related to the geology of the Guiana Shield. Rec. Geol. Surv. Guyana, Vol. 5, 60, 1967.

WIMPFEN, S., and BENNET, H., Copper Resource Appraisal, Resources Policy, Vol. 1, No. 3, 126-141, 1975.

WINDLEY, B.F., New tectonic models for the evolution of Archaean continents and oceans. In B.F. Windley (Ed.), The early history of the earth. Wiley, 105-112, 1976.

WINDLEY, B.F. and BRIDGWATER, D., The evolution of Archaean low and high-grade terrains. Geol. Soc. Aust. Spec. Publ., No. 3, 33-46, 1971.

WRIGHT, R.L. Ocean mining - an economic evaluation. Ocean Mining Administration. Dept. of Interior, 18, 1976.

WYNNE-EDWARDS, H.R., and HASSAN, Z., Intersecting orogenic belts across the North Atlantic, Amer. J. Sci. Vol, 268, 289-308, 1970.

ZIMMERMAN, E., Introduction to World Resources. New York, Harper and Row, 1964.

ZIMMERMAN, E., World Resources and Industries. New York, 1951.

ZORN, S.A., New developments in third world mining agreements. Natural Resources Forum, Vol. 1, No. 3, 239-250, 1977.

ZWARTENDYK, J., What is mineral endowment and how should we measure it? Can. Dep. Energy, Mines Resources, Miner. Bull., MR 126, 17, 1972.

APPENDICIES

Appendix 1:

List of materials sent to geologists for geostatistical analysis.

DEPARTMENT OF GEOLOGY

THE UNIVERSITY OF ALBERTA
EDMONTON, CANADA
T6G 2E8

February 27, 1978

Dear

I am currently enrolled in a doctoral program at the University of Alberta, and I am investigating the potential contribution of the mineral industry to Guyana's future development. My work therefore focuses on a physical evaluation which can be used as an input into a long-term exploration strategy for Guyana. The other aspect of my work is assessing the fiscal and institutional environment that will be consistent with mineral development, so that a framework for a mineral policy can be established.

As you are well aware, the assessment of the unknown mineral endowment of any region is extremely difficult, since there are so many unknowns. Traditionally, all such evaluations have been established on purely qualitative grounds with the principal variables being similarity and favourableness as exhibited elsewhere. The shortcomings of this approach are immediately obvious, as one attempts to assign scarce capital resources to various sectors of the economy, and, in our case, to various geographic areas of the country.

Increasingly, attempts are made to quantify these imponderables by statistical techniques of one form or another. Notable among such contributions are Alais' pioneering work in the Algerian Sahara in 1957, and Harris' (1967) contribution on multivariate geostatistical inference from knowledge of a control area.

In my study, the approach of Harris, Freyman and Barry (1970) in evaluating the potential mineral supply of the Canadian northwest is adopted. Essentially, this is a subjective probability approach where the accumulated knowledge of experienced geologists becomes the control area instead of the characteristics of a known geographic area as is done in the multivariate analysis. The exercise translates geologic opinion into probability distributions which describe the number of deposits with their tonnage and grade characteristics. Attached is an exerpt from Barry and Freyman's (1970) study, which explains the methodology of the approach.

You would agree with me that the approach is pregnant with meaningful possibilities. It calls on numerous man-years of experience which cannot be meaningfully captured by a literature search, while it permits a retrospective assessment of the various experts who are now in a better position to review their original opinions based on their subsequent endeavours.

As an experienced geologist who has worked in Guyana, your help is graciously solicited in this endeavour. This questionnaire will be circulated to your former colleagues of similar competence as well, and it is hoped that you will spare that extra moment to make a response.

I eagerly await your reply along with any other comments you consider appropriate at this time.

Yours sincerely,

Grantley W. Walrond

GWW:heh
Enclosure

NOTE ON METHOD

Theories on the processes of ore deposition may conflict in some particulars; however from the regional perspective, there is a consensus on the general geologic features that appear to be associated with the occurrence of ore deposits. Thus, geologic information on an area is indirect knowledge about the potential mineral resources of that area. It is an experience common to explorationists, however, that an area that appears nearly identical, in terms of geology, to another area which contains rich ore deposits may be barren of economic mineral occurrences. In this sense, for a given geologic environment, the occurrence of one or more deposits is a probabilistic event. It may well be, of course, that these two areas that appear to be identical would not appear so if more detailed information were available; nevertheless, at a specific level of information, this lack of information imparts to our evaluations an error that can be described in terms of probability.

The basic premise employed in this study is that mineral occurrence (endowment) is a function of the geologic processes that are reflected in the structural and lithologic characteristics of associated rocks. Thus, you are requested to draw upon your experience and scientific knowledge to evaluate the meaning of the geology of an area in terms of the probable occurrence of ore deposits of various tonnages and grades.

The objective of this project is an estimate of mineral resource potential as indicated by the geology. The geologist is not to consider the economics of exploration or exploitation in estimating probabilities of occurrence. On the contrary, the geologist is requested to think only in terms of the existence of a deposit within a minable depth of the earth's crust. Furthermore, since none of us have had any experience with an area in which we know all deposits have been found, probabilities based upon mineral density of areas with which we are familiar, will be downward biased; that is, they will tend to underestimate the mineral potential of the area, especially if our experience is with relatively 'young' areas that have not been intensively explored. The geologist is encouraged to make whatever upward adjustment in his estimate that he feels is in order so as to provide an estimate of occurrence.

Since we are interested in occurrence, not discovery, covered areas must be given special treatment; this means that for a cell with a thin but widely distributed cover (alluvium, glacial deposits, volcanic, etc.), the geologist must first make inferences about the underlying geology on the basis of what little is known on the cell and on the basis of the geology of adjacent cells. Then, with this projected geology, he is to estimate his probabilities of mineral occurrence. A modification of these probabilities made solely upon the projected geology is necessary in the case where thick cover is present, for if the cover is hundreds or even thousands of feet thick, the probability of occurrence of an ore deposit (except for placer) within the minable depth, is lower than in the case of no cover.

Evaluation of these factors and their effect upon the probabilities of occurrence for ore deposits is a difficult task, and in some cases it may appear a nearly impossible one. However, it is our belief that your opinion even on the difficult cases is more valuable than the alternative, which would be to employ a spatial model of mineral occurrence, such as that of Maurice Allais in which geology is not considered.

INSTRUCTIONS FOR FILLING IN THE QUESTIONNAIRE SHEETS

(i) Use one answer sheet for each cell.

(ii) Fill in the cell number and the latitude and longitude of the north-east corner of the cell on the top of the page.

(iii) Strike out the commodities on which you do not wish to comment.

(iv) For the commodities to which you would respond, indicate in the top left-hand corner (above the tonnage category) the most likely number of deposits of this commodity you would expect to find in that cell.

(v) For each cell, indicate on the bottom right-hand corner the total number of likely deposits of all kinds by placing the number 10 next to the specified total. e.g., if you have indicated 4 deposits of Cu and 2 deposits of lead-zinc (giving 6 total deposits) you should insert in the bottom right-hand corner of the sheet the number 10 next to the 5-7 category. If you use the 9-category, close it by specifying an upper limit.

(vi) Using a range of numbers of 1 to 9, (with 9 indicating the next most likely outcome), indicate above and below the most likely total number of deposits, that you have chosen, the likelihood of a different number of deposits occurring. e.g., if you feel that it is highly unlikely that only a total of 4 deposits can be found, then place a low number, 1 or 2, next to the 3-5 category. If you feel that there is a strong likelyhood that there are more than 6 deposits, indicate this in the 7-9 category by a high number, say 8 or 7.

(vii) Using numbers from 1 to 10, indicate within the commodity categories, the likely combination of tonnage and grade. Place at least three numbers under the commodity. Note: The likely combinations of tonnage and grade do not necessarily have to coincide with the number of deposits that you have indicated for that commodity. You are simply indicating the likelihood of different combinations occurring.

(viii) Translate secondary minerals into equivalent grade of the dominant commodity. e.g., the Cu category can include Co-Mo porphyry associations, hence translate Mo into Cu equivalents.

(ix) The "undifferentiated base metals" category is used to depict small to medium high grade replacement, and volcanogenic Cu-Zn etc. associations, as opposed to the large tonnage, low grade, Cu-porphyry type deposits, which would go under the Cu category.

(x) If you use the '300' category, close it with an upper limit.

NOTE that a cell is each 1 degree square. The cell numbers are indicated on the accompanying insert.

SIMULATION OF EXPLORATION EXPENDITURE REQUIREMENTS

The estimation of the investment required for the exploration stage of mineral activity is an extremely complex and difficult problem. Ideally, one would need to assess sequential appropriations to increasingly favourable areas over time. However, this is rather difficult to do, because of the uncertainty connected with the effort in each stage.

One approach would be to use the historical ratio of exploration costs to the average value of a mineral find as done by Brant (1968), Derry (1970), and Cranston-Martin (1973). Though this gives a rough historical indication of the magnitude of exploration costs involved per find, inter-country comparability of this data is difficult because of the different levels of exploration effort utilized in the respective countries. Secondly, where no significant discovery has been made as in relatively virgin areas such as Guyana, there is no historical perspective on which to rely. There is need therefore to develop an approach where an exploration function could be written for the specific setting.

In this approach, the informed opinions, and expectations of experienced explorationists are sought as a guide to developing the required exploration function. It is assumed that the probability of discovery is affected by:

(i) The type of terrain (rugged mountains, plains, etc.)
(ii) The amount of cover (alluvial, soil, forest, etc.)
(iii) The size of the deposit
(iv) The intensity of the search (size of exploration budget)

There will be 27 functions generated for the various combinations of deposit size, expenditure level, terrain and cover types.

Instructions

(1) In Table A, estimate 3 levels of exploration expenditure required to find a deposit (one is to be the low level, one the expected level, and the other high).

(2) In the same table, for each category of exploration expenditure, terrain and cover type, estimate the probability of finding a deposit. (Range of probabilities are from 0 to 1, with 1 indicating most likely, 0.5 representing likely, and 0 representing highly unlikely).

(3) Insert a number in each of the 27 boxes.

(4) In Table B, estimate the additional amount of exploration funds needed to find 1, 3, 7 and 15 additional deposits in each tonnage class.

(5) In the column labelled 'Expected expenditure', insert the total expenditure required for 2, 4, 8, 16 deposits. This figure is the sum of the 'expected' expenditure in Table A plus the additional expenditure required for an extra 1, 3, 7 and 17 deposits, as estimated in step 4.

Latitude and Longitude of N.E. Corner of Cell:

Cell No.:

Copper				Lead-Zinc				Molybdenum				Undifferentiated Base Metals			
	Grade %				Grade %				Grade %				Grade $/T		
Tons x 10^6	.1 ↓ .4	.5 ↓ 1.4	1.5 ↓ 2.0	Tons x 10^6	1 ↓ 5	6 ↓ 10	11 ↓ 20	Tons x 10^6	.05 ↓ .14	.15 ↓ .30	.40 ↓ .50	Tons x 10^6	5 ↓ 9	10 ↓ 29	30 ↓ 50
1-5				1-5				1-5				1-5			
5-10				5-10				5-10				5-10			
10-25				10-25				10-25				10-25			
25-50				25-50				25-50				25-50			
50-100				50-100				50-100				50-100			
100-300				100-300				100-300				100-300			
300-				300-				300-				300-			

Nickel				Tungsten				Iron				Uranium			
	Grade %				Grade %				Grade %				Grade %		
Tons x 10^6	.4 ↓ .5	.6 ↓ 2.5	2.6 ↓ 4.0	Tons x 10^6	.2 ↓ .4	.5 ↓ 2.0	2.1 ↓ 3.0	Tons x 10^6	15 ↓ 25	26 ↓ 45	46 ↓ 70	Tons x 10^6	.01 ↓ .04	.05 ↓ .3	.4 ↓ 1.0
1-5				1-5				1-5				.25-.50			
5-10				5-10				5-10				.50-1.0			
10-25				10-25				10-25				1-5			
25-50				25-50				25-50				5-10			
50-100				50-100				50-100				10-25			
100-300				100-300				100-300				25-50			
300-				300-				300-				50-			

Mercury				Gold-Silver				Tin				Manganese				Other			
	Grade				Grade $/T				Grade %				Grade %				Grade		
Tons x 10^6	.01 ↓ .09	.1 ↓ .5	.6 ↓ 3.0	Tons x 10^6	10 ↓ 24	25 ↓ 99	100 ↓ 200	Tons x 10^6	.2 ↓ .4	.5 ↓ 2.0	2.1 ↓ 3.0	Tons x 10^6	10 ↓ 19	20 ↓ 44	45 ↓ 60	Tons x 10^6	↓	↓	↓
.25-.5				.25-.5				1-5				1-5							
.5-1				.5-1				5-10				5-10							
1-5				1-5				10-25				10-25							
5-10				5-10				25-50				25-50							
10-25				10-25				50-100				50-100							
25-50				25-50				100-300				100-300							
50-				50-				300-				300-							

Number of Deposits	Probability
0	
1	
2	
3-5	
5-7	
7-9	
9-	

Comments:

Terrain 1	Rugged mountains, completely dissected; more than 3,000 feet of relief.
Terrain 2	Mountainous, dissected plateau; relief ranging 1,000 to 3,000 feet.
Terrain 3	Plateau or plain; hills, benches, relief less than 1,000 feet.
Cover 1	Little or no overburden.
Cover 2	Normal amount of overburden (20-50 ft.), soil, slide rock, and some laterite development, heavily forested.
Cover 3	Excessive amount of soil cover (more than 50 feet), heavily forested.

Tons Mill.	Expenditure		Terrain 1			Terrain 2			Terrain 3		
		$ mill.	Cover			Cover			Cover		
			1	2	3	1	2	3	1	2	3
1-5	Low										
	Expected										
	High										
5-50	Low										
	Expected										
	High										
50 +	Low										
	Expected										
	High										

Tons Mill.	Additional Deposits	Total No. of Deposits	Expected Expenditure ($)
1 - 5	1	2	
	3	4	
	7	8	
	15	16	
5 - 50	1	2	
	3	4	
	7	8	
	15	16	
50 +	1	2	
	3	4	
	7	8	
	15	16	

EXAMPLE

Latitude and Longitude of N.E. Corner of Cell: 7° N and 58° W

Cell No.: 7

Copper			
4	Grade %		
Tons × 10^6	.1 ↓ .4	.5 ↓ 1.4	1.5 ↓ 2.0
1-5			
5-10		5	
10-25	9		
25-50	2		
50-100		1	
100-300			
300-			

Lead-Zinc			
2	Grade %		
Tons × 10^6	1 ↓ 5	6 ↓ 10	11 ↓ 20
1-5		8	
5-10		6	
10-25	3		
25-50			1
50-100			
100-300			
300-			

Molybdenum			
	Grade %		
Tons × 10^6	.05 ↓ .14	.15 ↓ .30	.40 ↓ .50
1-5			
5-10			
10-25			
25-50			
50-100			
100-300			
300-			

Undifferentiated Base Metals			
	Grade $/T		
Tons × 10^6	5 ↓ 9	10 ↓ 29	30 ↓ 50
1-5			
5-10			
10-25			
25-50			
50-100			
100-300			
300-			

Nickel			
	Grade %		
Tons × 10^6	.4 ↓ .5	.6 ↓ 2.5	2.6 ↓ 3.0
1-5			
5-10			
10-25			
25-50			
50-100			
100-300			
300-			

Tungsten			
	Grade %		
Tons × 10^6	.2 ↓ .4	.5 ↓ 2.0	2.1 ↓ 3.0
1-5			
5-10			
10-25			
25-50			
50-100			
100-300			
300-			

Iron			
	Grade %		
Tons × 10^6	15 ↓ 25	26 ↓ 45	46 ↓ 70
1-5			
5-10			
10-25			
25-50			
50-100			
100-300			
300-			

Uranium			
	Grade %		
Tons × 10^6	.01 ↓ .04	.05 ↓ .3	.4 ↓ 1.0
.25-.50			
.50-1.0			
1-5			
5-10			
10-25			
25-50			
50-			

Mercury			
	Grade		
Tons × 10^6	.01 ↓ .09	.1 ↓ .5	.6 ↓ 3.0
.25-.5			
.5-1			
1-5			
5-10			
10-25			
25-50			
50-			

Gold-Silver			
	Grade $/T		
Tons × 10^6	10 ↓ 24	25 ↓ 99	100 ↓ 200
.25-.5			
.5-1			
1-5			
5-10			
10-25			
25-50			
50-			

Tin			
	Grade %		
Tons × 10^6	.2 ↓ .4	.5 ↓ 2.0	2.1 ↓ 3.0
1-5			
5-10			
10-25			
25-50			
50-100			
100-300			
300-			

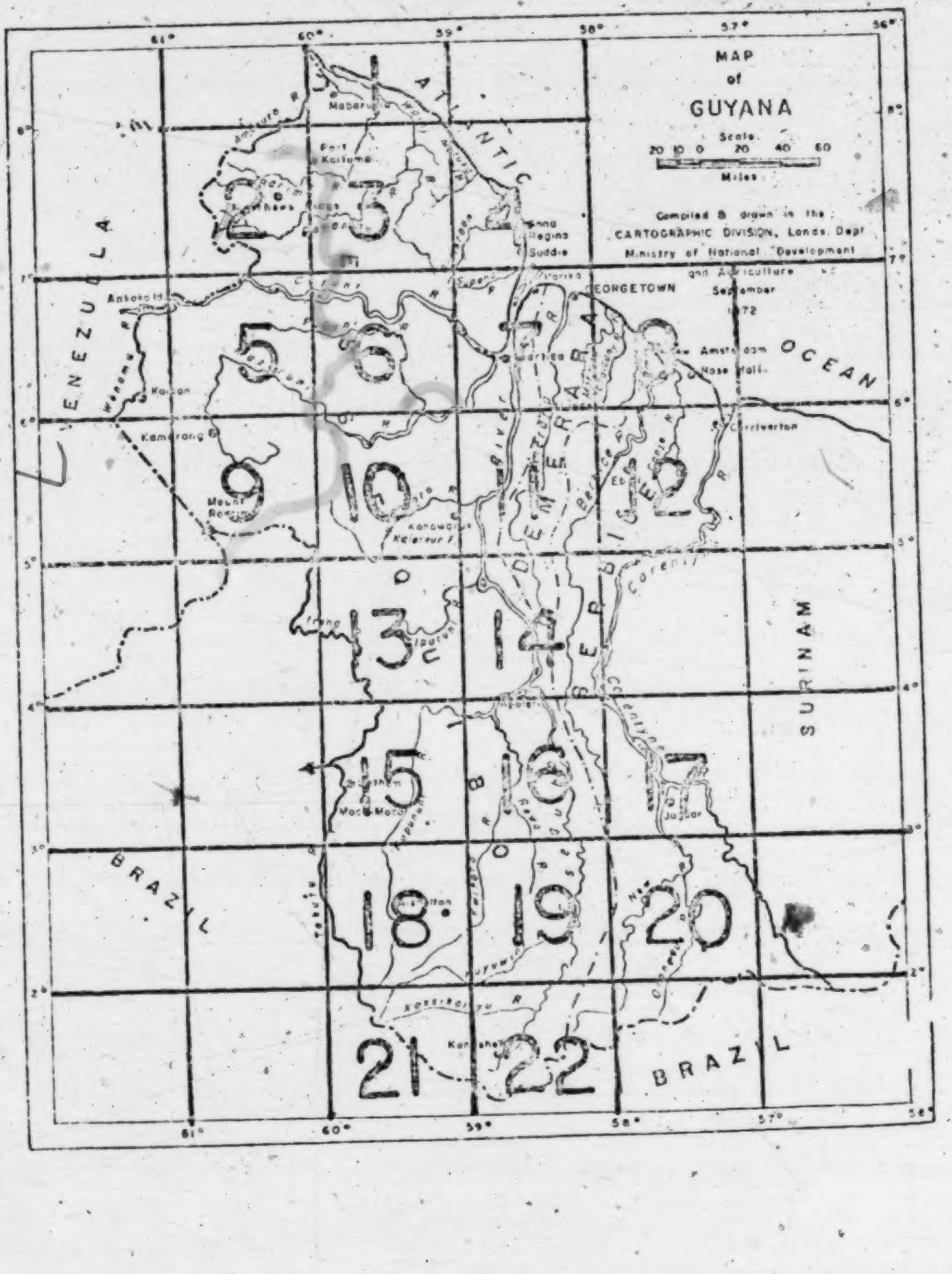
Manganese			
	Grade %		
Tons × 10^6	10 ↓ 19	20 ↓ 44	45 ↓ 60
1-5			
5-10			
10-26			
25-50			
50-100			
100-300			
300-			

Other			
	Grade		
Tons × 10^6	↓	↓	↓

Number of Deposits	Probability
0	
1	
2	
3-5	2
5-7	10
7-9	8
9-	

Comments:

GUYANA


MAP
of
GUYANA
Scale.
20 10 0 20 40 60
Miles
Compiled & drawn in the
CARTOGRAPHIC DIVISION, Lands. Dept
Ministry of National Development
and Agriculture
September
1972
61°
60°
59°
58°
57°
56°
8°
7°
6°
5°
4°
3°
2°
1
2
3
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
ATLANTIC
OCEAN
VENEZUELA
BRAZIL
SURINAM
BRAZIL
GEORGETOWN
New Amsterdam
Rose Hall
Corriverton
Mabaruma
Port Kaituma
Anna Regina
Suddie
Kamarang
Mount Roraima
Kaieteur F.
Mocha Mocha
Jaguar
DEMERARA
BERBICE
ESSEQUIBO
Cuyuni R
Mazaruni R
Corentyne
Rupununi

APPENDIX 2

Guystac Group of Companies

Ref:Guyana in Brief by GIS

Public Utilities and Services Group

1. Guyana Airways Corp.
2. Guyana Electricity Corp.
3. National Insurance Scheme
4. Guyana Housing Corp.
5. Guyana Transport Services Ltd.

Trading Group

6. External Trade Bureau
7. Guyana National Trading Corporation Ltd.
8. Guyana Gajraj Limited
9. Guyana Wirefords Limited
10. Guyana Stores Limited
11. Guyana National Lithographic Co. Ltd.
12. Guyana National Pharmaceutical Corporation
13. Guyana National Shipping Corp.
14. Guyana Oil Company Ltd.

Information and Communication Services Group

15. Guyana Telecommunication Corp.
16. Guyana Broadcasting Service
17. Guyana National Newspapers Ltd.
18. Guyana Printers Ltd.

Agriculture Products and Food Processing

19. Guyana Agricultural Products Corporation
20. Guyana Marketing Corporation
21. Guyana Mineral Foods Ltd.
22. Guyana Food Processors Ltd.

Industries Group

23. Guyana Timbers Ltd.
24. Small Industries Corporation
25. Guyana Forest Industries Corporation
26. Guyana Rice Board
27. Guyana National Engineering Corporation Ltd.
28. Post Office Corporation

APPENDIX 3

GOLD PRODUCTION 1884 - 1974

Yrs.	Quartz Milling	Hydraulicking	Dredging	Alluvial Washing	Total Bullion Ounces
1884				250	250
85				939	939
86				6,518	6,518
87				10,987	10,987
88				20,216	20,216
89				32,333	32,333
1890				66,864	66,864
91				110,556	110,556
92				134,124	134,124
93				138,528	138,528
94	621			132,374	132,995
95	44			121,241	121,285
96	6,695			120,784	127,479
97	4,625			116,866	121,491
98	1,855			111,259	113,114
99	88			112,702	112,790
1900				114,102	114,102
01				101,332	101,332
02		225	130	102,142	104,527
03		4,524	43	85,762	90,336
04		13,075	1,233	81,556	95,864
05	3,664	7,269	687	82,743	94,363
06	9,501		1,561	74,443	85,505
07	5,815	74	4,133	57,188	67,210
08	13,287	950	3,868	55,550	73,655
09	13,626	6,192	4,461	40,551	64,830
1910	6,387	2,710	7,294	38,598	54,989
11	1,574	252	9,569	38,879	50,274
12	437	823	12,033	38,472	51,765
13		243	10,104	72,359	82,706
14			12,608	52,374	64,982
15	108		9,990	29,696	39,794
16	1,103		11,967	24,059	37,129
17			10,384	19,155	29,539
18			7,556	16,991	24,547
19			5,237	10,980	16,217
1920			6,238	6,454	12,692
21			6,770	6,059	12,829
22			5,313	5,564	10,877
23			4,463	2,799	7,262
24			5,292	1,895	7,187
25			6,787	2,320	9,107

Appendix 3 (cont'd)

Yrs.	Quartz Milling	Hydraulicking	Dredging	Alluvial Washing	Total Bullion Ounces
1926			5,874	1,576	7,450
27			3,975	2,748	6,723
28			3,431	2,652	6,083
29			3,851	3,443	7,294
1930			1,821	5,112	6,933
31			1,613	9,479	11,092
32			2,789	12,382	15,171
33			3,102	22,337	25,439
34			2,821	24,870	27,691
35			2,165	31,046	33,211
36			2,694	32,420	35,114
37			3,420	35,788	39,208
38			6,421	35,499	41,920
39			8,272	31,235	39,507
1940			8,633	27,112	35,745
41			9,901	26,144	36,045
42			11,607	17,659	29,266
43	6,031		6,863	6,576	19,470
44	5,259		6,000	6,927	18,986
45	9,129		8,442	4,966	22,533
46	11,533		9,163	4,045	24,741
47	13,307		7,967	5,115	26,389
48	11,408		7,489	1,751	20,648
49	10,218		9,851	1,028	21,098
1950	5,338		7,444	958	13,740
51	1,010		11,846	1,838	14,689
52	1,446	18	20,240	2,519	24,223
53	1,584	41	16,674	2,667	20,966
54	304		23,230	3,404	26,938
	145,690	38,426	342,890	2,758,458	3,285,464
1955					23,766
56					15,815
57					16,491
58					17,500
59					3,447
1960					2,364
61					1,702
62					1,903
63					2,848
64					2,111
65					2,077
66					3,045
67					2,379

Appendix 3 (cont'd)

Yrs.	Quartz Milling	Hydrau-Licking	Dredging	Alluvial Washing	Total Bullion Ounces
1968					4,088
69					2,102
1970					4,433
71					1,407
72					4,027
73					7,551
74					12,240
75					18,067

Source: Government of Guyana Mines Department.

APPENDIX 4

Gold Production from 1955 to 1974 (ozs)

MONTHS	Period					
	1955-1958	1959-1962	1963-1966	1967-1970	1971-1974	1955-1974
January	6691	878	795	220	685	9 269
February	6205	1011	879	1358	1076	10 529
March	5641	1009	806	1041	2124	10 621
April	7755	448	788	727	2124	11 842
May	8356	540	931	1130	2306	13 263
June	6138	494	532	975	2101	10 240
July	6539	566	722	1172	2281	11 280
August	4678	1023	539	1238	2400	9 898
September	5877	627	585	1351	2066	10 506
October	5363	901	1470	806	3582	11 122
November	5211	734	752	1072	3092	10 861
December	4517	1137	1311	1601	2388	10 954

Source: Compiled from various files in Government of Guyana Mines Department.

APPENDIX 5

OPERATOR'S QUESTIONNAIRE

1. Home address:
2. Type of mining:
3. Mineral mined:
4. Claims:
5. Location of claims:
6. Mode of transport to site:
7. Number of years in activity (periods):
8. Average annual income $ (mining): 0 - 3000; 3000-6000; 6000 - 9000; 9000-12,000; 12,000 - 15,000, > 15,000
9. Average annual income $ (total):
10. Highest income received:
11. Period of highest income:
12. Capital outlay:
13. Source of funds (sponsor):
14. Payments to sponsor (share):
15. Type of equipment:
16. Fuel costs:
17. Labour (Number of workers):
18. Payments to labour (sharing agreement, if applicable):
19. Labour costs (if hired):
20. Assistance by Government:
21. Other source of income (farming, etc.):
22. Comments:

OPERATOR'S QUESTIONNAIRE II

1. Name of Claim
2. Name of Claim Holder
3. Type of Claim
    - a. Gold b. Gold and Precious Stones
    - c. Precious Stones d. River
4. Terrace, Creek beds or Flats
5. Method of Working
    - a. Pit b. Hydraulicking c. Ground Sluicing
6. Size of Pit or Open Ground
7. If Pits, Number Pits
8. Thickness of Gravel - Grade -
9. Thickness of Overburden
10. Nature of Bedrock
11. Any Other Minerals Seen
12. Mechanisation (Gravity or Pump etc.)
13. Method of Washing
    - a. Tom and Chest b. Tom and Baby c. Sluice
    - d. Warrior e. Scrambler f. Other (specify)
14. Is Mercury Being Used
15. Is Claim Holder Working

FOR DREDGING OPERATIONS ONLY

16. Number of Barges on Claim
17. Number of Divers Working
18. Depth of Water Mean .... ft. High .... ft.
    Low .... ft.
19. Time Spent Underwater by Divers per Shift.
20. Thickness of Gravel
21. Grade of Gravel
22. Size of Material in Gravel, e.g. Pebbles
23. Nature of Gravel
    - a. Loose b. Consolidated c. Cemented
24. Clay Content of Gravel
25. Dimensions of Pit (area) Being Worked

APPENDIX 6: Table 1

Distribution of Claims by District For 1965

District and Type Claim	No of Claims 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	47	52
# 1 PS	1																																
# 1 RL																				1													
# 1 G	25	12	3		1	3																										1	
# 2 PS	51	33	11	4	8		1	1	6	2	1	1	1			1		1		1													
# 2 M																										1							
# 2 G&PS	2																																
# 2 RL	13	3	4	1	3	2		2			1	1		1			1																
# 3 G	7	5	1	2			1					2										1			1								
# 3 PS	343	117	41	24	11	7	4	2	4		3	2		3		2						2				1							
# 3 G&PS						1																											
# 3 RL	15	10	9	6	1	2	2	3	1	3					2							1				1							1
# 4 G	3	6		2		1																											
# 4 PS	4	7					1	1			4	2	3																				
# 4 RL	4	3		1		1	1				2		1							1													
# 5 G	4	2	5															1															
# 6 PS	17	14	6	2			1	2								1	1																
# 6 G	1															1																	
# 6 RL				1				1																									

Types of Claims: PS-Precious Stones; RL-River Location; G-Gold
Size of RL is 1 mile, sizes of other claims are 1500 feet by 800 feet.
Districts: 1-Berbice; 2-Potaro; 3-Mazaruni; 4-Cuyuni; 5-North West District; 6-Rupunui.
Sources: Compiled from the Government of Guyana Official Gazette (1966).

Note: The entries represent the number of persons holding a specific claim type.

APPENDIX 6: Table 2

Distribution of Claims by District For 1978

District and Type Claim	No of Claims 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	28	32	36	50	93
# 1 PS	1	1																												
# 1 RL		1									1																			
# 2 G	20	19										2																		
# 2 PS	35	14	12	12	3	3	1	3	2	2			3	1						1										
# 2 PM																												1		
# 2 RL	6		3	1	3	2		1																		1				
# 3 G	5	2	1	3				1																			1			
# 3 PS	260	106	37	18	7	6	2	4	1		1	3	2	1		1			1			1					1			1
# 3 G&PS	27	5		1																										
# 3 M							1																							
# 3 RL	7	10	6	5	4	3		1				1	1	1	1	1														
# 4 G	3	3	1			2																								
# 4 PS	15	13	3	2	1	2		2	1	1																			1	
# 4 RL	7	2			1	1	1	2	1	1	1																			
# 5 G	4	1	6	1		1																								
# 5 RL	6																													
# 6 G	3																													
# 6 PS	13	10	5	2	3	2		2				1					1													
# 6 RL	1	2		3	1																									

Types of Claims: PS-Precious Stones; RL-River Location; G-Gold
. Size of RL is 1 mile long; size of other claims - 1500 feet by 800 feet.
Districts: 1-Berbice; 2-Potaro; 3-Mazaruni; 4-Cuyuni; 5-North West District; 6-Rupununi.
Sources: Compiled from Government of Guyana Official Gazette.

Note: The entries represent number of persons holding a specific claim type.

APPENDIX 6: Table 3

Distribution of Claims by Districts For 1975

District and Type Claim	No of Claims 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	28	31	32	35	37	39	50
# 1 RL			1			1																										
# 2 G	18	14	4	3	2	1		1				2																	1			
# 2 PS	38	18	11	8	4	2	3	1		2			2		1	2				1												
# 2 RL	4	10	7	2	7	2	1		3			2	1																		1	1
# 3 G	15	2	1	2						1		3												1		1		1				
# 3 PS	720	44	20	12	2	3	4	1		2	2	1			1																	
# 3 G&PS	14	1	2																													
# 3 RL	11	13	6	3	2		3			2	1	2	1	1	2																1	
# 4 G	8	1	2		1	2							1																			
# 4 PS	34	20	9	6	2	1	1			2	1																					
# 4 G&PS	4	1																														
# 4 RL	8	5	3	5	3			1		1	1																		1			
# 5 G	11	10	9	2				1																								
# 5 RL	1			1									1																			
# 6 G	1			2		1																								1		
# 6 PS	8	12	6	9	3		3		2		1			1		1																
# 6 RL	3			1				1																								
# 2 GSPS	2	3																														

Types of Claims: PS-Precious Stones; RL-River Location; G-Gold
Size of RL is 1 mile long; size of other claims is 1500 feet by 800 feet.
District: 1-Berbice; 2-Potaro; 3-Mazaruni; 4-Cuyuni; 5-North West District; 6-Rupununi.
Sources: Compiled from Government of Guyana Official Gazette (1975).

Note: The entries represent the number of persons holding a specific claim type.

APPENDIX 7

Generalization of Scale of Mining Operations Usually Associated with Specific Minerals

Mineral	Typical Scale of Mining Operations				
	Usually large	Medium to large	Usually small	Important small-scale component	Co-product or by-product
Aluminum a/	X				
Antimony				X	X
Arsenic, white					X
Asbestos		X		X	
Barite			X		
Bauxite	X				
Beryl			X		
Bismuth				X	X
Boron		X			
Cadmium					X
Cement, all grades b/		X		X	
Chromite		X		X	
Clays			X		
Coal, all grades		X		X	
Columbium-tantalum			X		X
Copper, mine	X			X	
Copper, Smelter a/	X				
Diamond, gem		X		X	
Diamond, industrial		X		X	
Diatomite		X			
Feldspar			X		
Fluorspar			X		
Gem stones, precious			X		
Gem stones, semi-precious			X		
Gold		X		X	X
Graphite		X		X	
Gypsum			X		
Iron ore	X				
Lead, mine		X		X	
Lead, smelter a/		X		X	
Lithium minerals			X		
Magnesite, crude			X		
Magnesium metal a/	X				
Manganese ore		X		X	
Mercury			X		
Mica, including scrap			X		
Molybdenum	X				X
Nickel		X			
Peat			X		
Phosphate rock		X			
Platinum-group metals		X			
Potash, K_2O equivalent	X				
Pumice			X		
Pyrite, including cuprous		X			
Rare earth minerals, all			X		X
Salt		X		X	
Selenium					X
Silver		X		X	X
Strontium minerals			X		
Sulphur, native		X		X	
Sulphur, byproduct (including recovered)		X			X
Talc, soapstone, prophyllite			X		
Tellurium					X
Tin, mine		X		X	
Tin, smelter a/	X				
Titanium, ilmenite		X			
Titanium, rutile		X			
Tungsten			X		X
Uranium minerals		X		X	
Vanadium		X			X
Vermiculite			X		
Zinc, mine		X			
Zinc, smelter a/		X			
Miscellaneous construction and industrial minerals		X		X	

a/ The pyrometallurgical production of metals from ores and concentrates is usually, but not always, a concomitant of large-scale mining. Artisanal operations do smelt copper, lead and iron, for example.

b/ Although cement is not, strictly speaking, a mine product, it is usually produced at at near the mine and is a specific mineral product of advanced processing carried out at the mine. It is one of the few (mercury is another) which are often the end products of small-scale mining operations.

Source: U.N. (1974).

APPENDIX 8

CLASSIFICATION OF MINERAL RESOURCES AND STAGES OF GEOLOGICAL INVESTIGATION FOR UTILISATION OF RAW MATERIALS IN GUYANA

CATEGORY	PROGNOSTIC RESOURCES		IDENTIFIED RESERVES		
	SPECULATIVE (E)	HYPOTHETICAL (D)	POSSIBLE (C)	PROBABLE (B)	PROVEN (A)
geological exploration stage	stage 1	stage 2	stage 3	stage 4	stage 5
NECESSARY INFORMATION ON: GEOLOGY	Scientific prediction of utilisable raw materials on the basis of the present knowledge about geneses, geological conditions and geophysical and geochemical information.	Rough estimate of the total reserves of the unit on the basis of mode of occurrence and possible genesis, geological condition, outcrops or occurrences, geophysical and geochemical results.	Determination of the vertical and horizontal extention of the deposit or a part of the ore body and the hydrogeological conditions by few bore holes, trenches or pits with large centres. Accurate description of the genesis. Calculation of reserves. Determination of nature and thickness of overburden.	Definition of the deposit or a part of the ore body including the variability of all the important parametres including hydrogeological and geological engineering conditions by drill holes, trenches, or mining operations. Calculation of reserves; dense drill hole centres (usually half the distance between bore holes as employed in geological exploration stage 3)	Final appraisal of the deposit (variability, overburden, hydrological and geological engineering conditions) arising from denser bore hole centres (usually half the distance between bore holes as employed in geological exploration stage 4)
TECHNOLOGY	Scientific prediction of the quality based on genesis by analogy with known deposits and show found.	Laboratory tests on samples from outcrops and first assessment of the quality.	Determination of average quality and assessment of its variability, including first semi-industrial tests on representative samples, first conclusion about the technology.	Definition of the quality and its variability within the deposit, large scale industrial bulk-testing. Projection of the factory on the basis of these results (incl. capacity, nature of input and output, technology)	Qualitative appraisal of the raw materials based on current acceptable cut off grades, information for directing of the mining operations.
MINING	Scientific prediction of the mining conditions on the basis of geological conditions and by analogy with known deposits.	Assessment of the mining conditions on the basis of geological conditions in the area and the geological environment, the outcrop or the occurrence.	Feasibility study for a mining operation on the basis of the geological information.	Mining project (equipment, capacity, method in detail)	Planning of mining operations in detail.
ECONOMICS	First economic assessment of technological and mining conditions, accessibility of the area, importance for the country, price and market. Decision about the present economic feasibility.	Assessment of the economic feasibility on the basis of the present information	Feasibility study of the economic conditions including calculation of costs, the price, studies on the national and international markets Decision about the economic feasibility.	Marketing and calculation of the economic parameters of the operations.	Selling arrangement and finalising of economic conditions, planning and management.
ESTIMATED RISK OF THE RESULTS	> 50%	≦ 50%	< 30%	< 20%	< 10%
ECONOMIC FEASIBLE	Next geological investigation or exploration step should be planned according to the importance for the economy of the country.				
ECONOMIC NONFEASIBLE	At present no further work: Check the reason from time to time.				

INCREASING ASSURANCE ABOUT: GEOLOGICAL
TECHNOLOGICAL
MINING AND
ECONOMIC
CONDITIONS

APPENDIX 9

Principal Outlets for Mineral and Metal Products

	Captive	Producer	Merchant	Other
Aluminum	X	X		
Antimony		X		
Beryllium			X	
Bismuth		X		
Cadmium		X		
Chromium			X	
Cobalt		X	X	
Columbium		X	X	
Copper	X	X	X	
Ferroalloys			X	
Germanium		X		
Gold				X
Iron	X	X	X	
Lead		X	X	
Magnesium		X		
Silver			X	X
Manganese	X	X		
Molybdenum		X		
Nickel		X		
Platinum			X	
Tantalum		X	X	
Tin			X	
Titanium			X	
Tungsten			X	X
Vanadium		X		
Zinc		X		
Phosphate	X	X		
Potash	X	X		
Sulfur		X		
Feldspar		X		
Fluorspar	X	X	X	
Barite	X	X	X	
Asbestos	X	X	X	
Mica		X	X	
Pyrites		X	X	
Salt	X	X		
Gypsum	X			
Coal	X	X		
Peat		X		X
Gas		X		X
Petroleum		X		X

Source: Kruger (1976).

APPENDIX 10(a)

Table 2a: Reserve - Output & Resources - Capacity in the Nickel Industry

Countries	Reserves x 10^3 Tons	Production x 10^3 Tons	Reserves/ Output	Total Resources x 10^3 Tons	Capacity x 10^3	Resources/ Capacity
United States	200	14	14.3	15,200	11	1381.8
Canada	9,600	269	35.7	17,900	375	47.7
U.S.S.R	5,700	150	38.0	10,000	175	57.1
Australia	5,500	44	125.0	8,000	95	84.2
Colombia	500	---	---	1,000	---	---
Cuba	3,400	35	97.1	20,000	70	285.1
Dominican Republic	1,000	26	38.5	1,100	36	30.6
Guatemala	600	---	---	1,500	15	100.0
Puerto Rico	---	---	---	900	---	---
Indonesia	5,000	23	217.4	6,100	93	65.6
New Caledonia	26,000	109	238.5	27,000	166	162.7
Phillipines	1,200	---	---	8,000	40	200.0
Africa	800	---	---	5,000	---	---
Other	---	29	---	1,400	50	28.0
WORLD TOTAL	59,500	722	82.4	123,100	1183	104.1

Source: Modified from Wright (1976).

APPENDIX 10(b)

Reserves as of 1974

Noranda Group

Mines	Reserves (tons)	Output[a] (tons)	R/O
Noranda[1]			
Gaspe (98.9% interest)	136,285,000	7,298,300	18.67
Brenda (50.9% interest)	268,900,000	10,547,000	25.50
Brunswick (64.2%)	159,000,000	9,550,000	16.65
Central Canada Potash (51%)	98,923,000	2,608,000	37.93
Kerr (43.8%)[2]	587,000,000	2,721,000	215.73
Mattagami Lake (42.7%)[3]	---	687,200	---
Parnour Porcupine (48.8%)	26,159,000	2,546,000	10.27
Placer (33.2%)[4]	5,223,000	1,783,000	2.93
Orchan (50.8%)	529,600,000	22,405,000	23.64
	3,342,000	364,000	9.18

[1] Includes Horne, Geco, Bell Copper and Boss Mountain.

[2] Includes Kerr, Normetal, Joutel.

[3] Includes Mattagami and Mattabi.

[4] Includes Endako, Craigmont and Gibraltar.

[a] Output represented by ore treated.

Source: Noranda Annual Reports (various years).
Porphyry Deposits of the Canadian Cordillera, ed. A. Sutherland-Brown, 1977.

APPENDIX 10(c)

Reserves - Output as of 1976 for AMAX

	Reserves	% MoS_2	Output[a]	R/O
Climax	462,000,000	0.32		
Henderson	300,000,000	0.49		
Total	762,000,000		16,000,000	47.63
Keystone	130,000,000	0.40		
Amax Total	892,000,000		16,000,000	55.75

[a] Output represented by ore treated.

Sources: World Mining, Nov. 1977.
Mining Annual Review, 1977.

APPENDIX 11

Investment Requirements in the Copper Industry

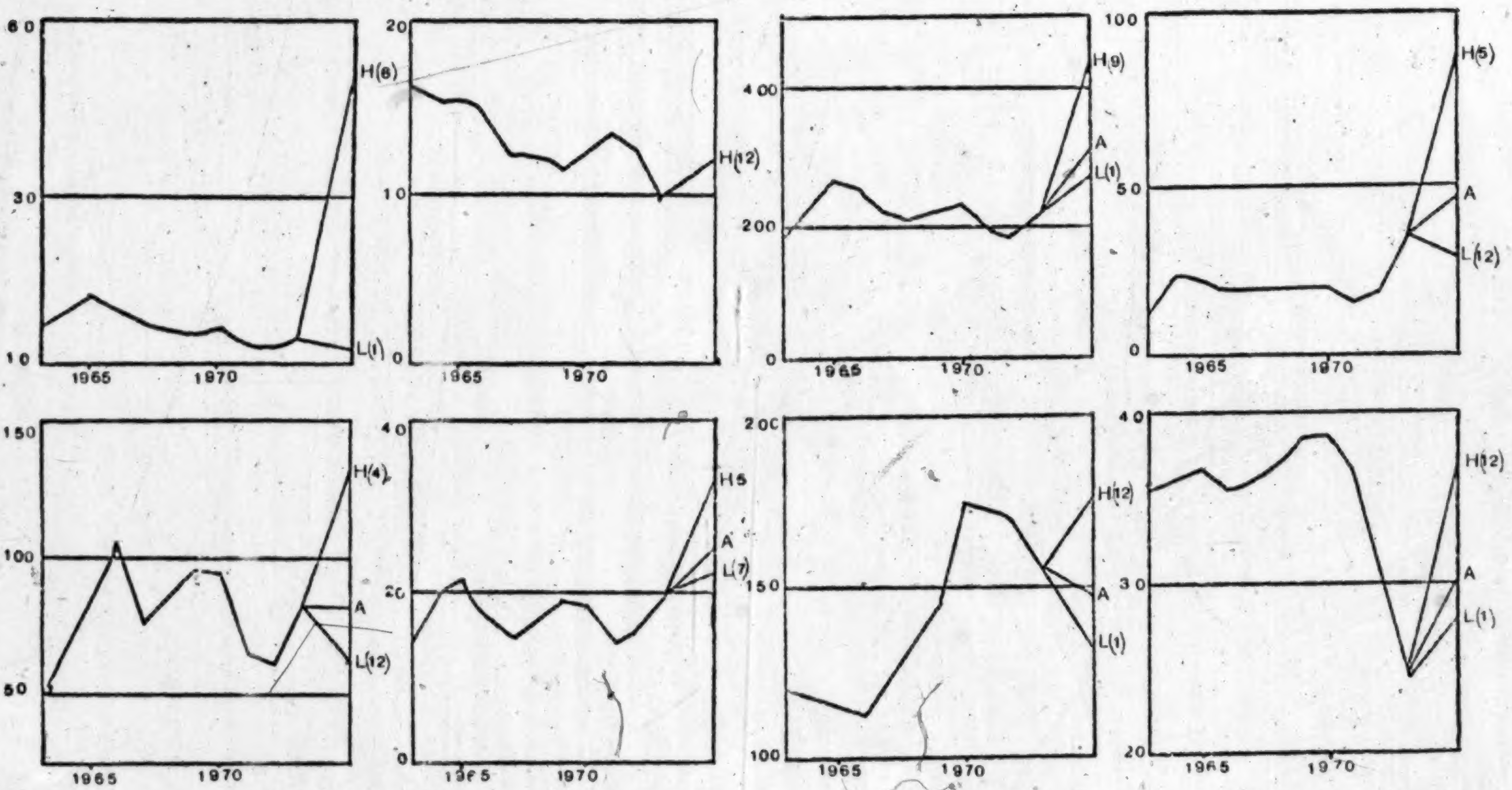
(U.S. Dollars)

Type of Operation	Size of Operation Tons/Day	Capital Investment x 10^6 Dollars	Operating Costs Dollars per Ton
Mining	30,000	\$ 9.7	\$0.39
	180,000	\$ 48.3	\$0.27
Concentrating	5,000	\$ 13.4	\$2.03
	72,000	\$120.7	\$1.14
Smelting & Refining	300,000	\$ 57.0	5¢ per lb.

Source: Wimpfen and Bennett (1975).

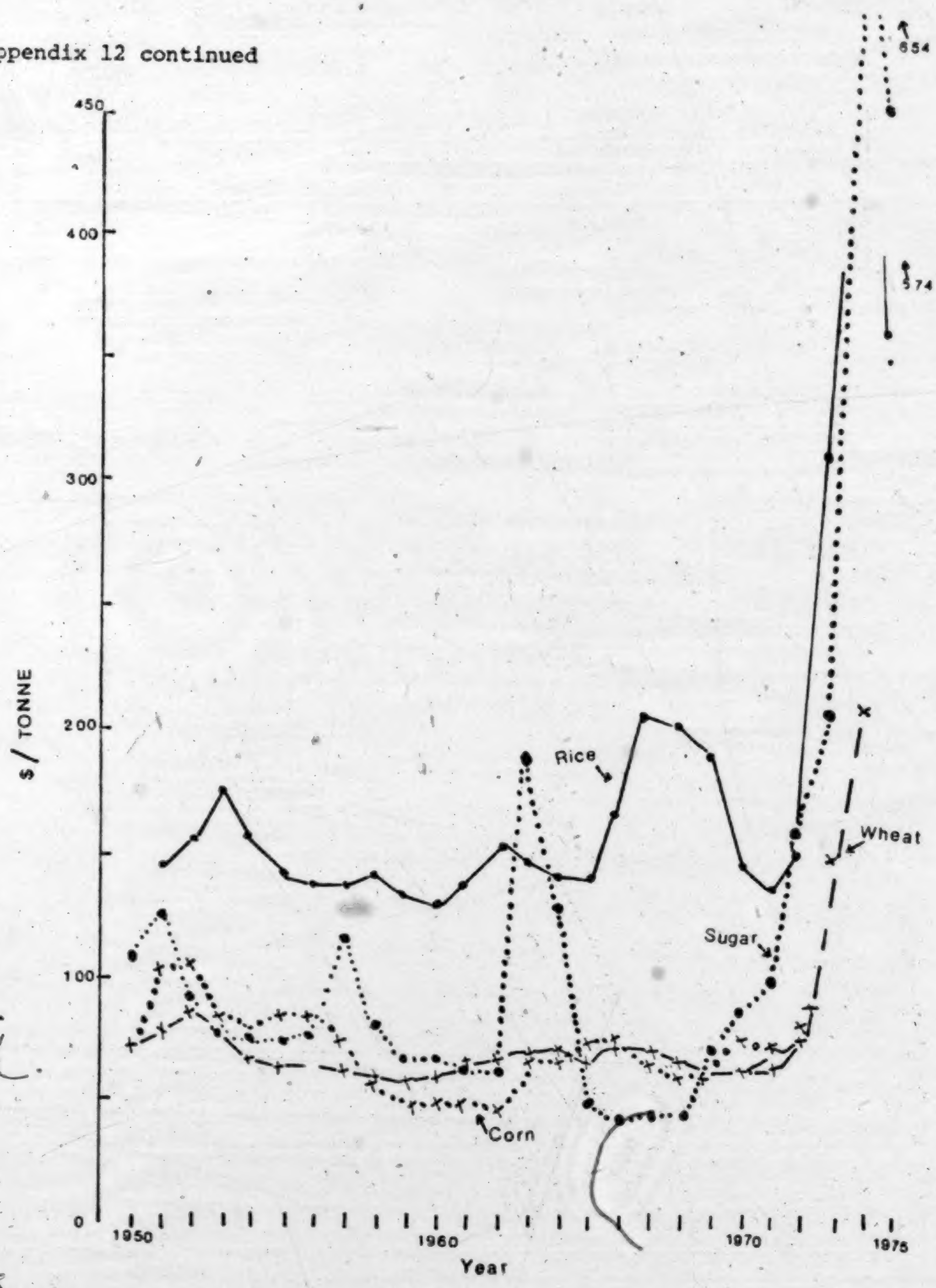
APPENDIX 12

Deflated Prices of Selected Minerals and Metals,
1963-73, and Average (A), High (H), and Low (L) for 1974 (1973-74 Enlarged)



Source: UNCTAD, "An Integrated Programme for Commodities: The Role of International Commodity Stocks", (TD/B/C1/166/supp.1/add.1) (New York, December 13, 1974); and Monthly Commodity Price Bulletin.

Appendix 12 continued



Source: UNCTAD (1974)

APPENDIX 13

Non-fuel Minerals: capital cost per metric ton of annual production capacity (in 1975 U.S. dollars)

Commodity-activity	Capital cost per ton of capacity
Bauxite mining	85
Alumina refining (integrated)	510
Alumina refining (non-integrated)	750
Aluminum smelting (integrated)	1900
Aluminum smelting (non-integrated)	2800
Copper mining	3000-5000
Copper smelting-refining	2000
Iron ore mining	65-115
Iron ore pelletizing	20-35
Iron ore mining-pelletizing	75-125
Lead mining-refining	790-1400
Manganese ore mining	235-400
Nickel mining	
Nickel laterite ore	19 500-31 000
Nickel oxide ore	11 000-22 000
Phosphate rock mining	50
Tin mining (dredging)	15 000
Tin mining (gravel pump)	10 000
Zinc mining-smelting	800-1400

Notes:
- i Where a range is given it represents variations on capital cost due to location of major projects, differing infrastructure requirements, differences in production methods and whether the project involves the construction of new capacity or the replacement of existing capacity.
- ii Capital costs for bauxite, copper, phosphate rock and tin do not include investments needed for related infrastructure.
- iii Capital cost for phosphate rock of $50 per ton of capacity relates to 1975 and it is assumed that the cost will increase by 3% annually thereafter.

Source:

Takeuchi et al. (1977).

APPENDIX 14

List of Gold Prospects Compiled by the Geological Surveys Department

CLASS I: HARD ROCK PROSPECTS

Four(1) hard rock prospects have been studied in this report; they are listed in decreasing order of priority.

I. MARUDI MOUNTAIN:

Probable reserves = 250,000 tons at 0.345 oz/ton

Speculative reserves = 10,000,000 tons (unknown grade)

Work was terminated at this prospect because the mining company, Rupununi Gold Mining, was unable to raise funds for further exploration. No mining on a commercial scale was done here, so this prospect can be regarded as virgin territory. Compared to the other hard rock prospects, this one has the most to show for the amount of work done.

II. PETERS' MINE:

Proven reserves = 16,000 tons at 0.95 oz/ton

Probable reserves = 22,500 tons at 0.95 oz/ton

Possible reserves = 187,500 tons at 0.95 oz/ton

This prospect has been worked profitably in the past and would need the least amount of work (of the four hard rock prospects) to bring all the reserves to the proven stage. With the expected completion of the hydropower road, which passes through this area, transportation difficulties will be minimal. This prospect is a relatively small one in terms of potential ore, but there is some possibility for finding more in the area.

III. OMAI MINE:

No exact figures for potential reserves are available, but the following data is taken from the files of Anaconda Mining Company.

A limited (unknown) tonnage at between 0.12 and 0.25 oz/ton. A probable few million tons at an average of 0.09 oz/ton.

A larger tonnage at between 0.04 and 0.07 oz/ton.

This prospect falls in the large volume-low grade category. Anaconda carried out a detailed and extensive exploration programme, but unfortunately, many of the assays have become indecipherable on the drill hole sections, and as such, reserves cannot be worked out. To date, efforts to obtain fresh copies from Anaconda have been unsuccessful.

No commercial mining has been done here either. This prospect may need more work than the previous two, because the gold is not concentrated in quartz veins, but is spread throughout the host rock.

IV. AREMU:

The gold is present in a system of quartz veins. There are about a dozen such veins, some of them large (30' wide and 1000' wide). However, in all cases, the ore grade intersections are much less than the width of the vein.

Diamond drilling and exploration work has indicated spotty and erratic mineralisation in most of the veins with small ore grade intersections in a few of them. Because of this, drill holes would have to be very closely spaced and more bulk sampling done.

CLASS II: ALLUVIAL - ELUVIAL PROSPECTS

Three alluvial-eluvial prospects have been studied. They would all need detailed pitting, augering or Banka drilling, and batel washing to re-evaluate the remaining reserves. The prospects are listed in decreasing order of importance. (All figures rounded to reflect uncertainty).

I. ARANKA:

Possible reserves = 20,339,000 cu.yds. at 1.01 gr/cu.yd.
(alluvial) = 42,800 ozs
Probable reserves = 1,000,000 cu.yds. at 8.5 gr/cu.yd.
= 17,700 ozs

II. ARAKAKA:

Possible reserves = 2,000,000 cu.yds. at 8.2 gr/cu.yd.
= 34,170 ozs

Although gold was obtained from crushed quartz veins here in the past, it is doubtful that any substantial production can come out of the veins remaining. The veins are thin at the surface and have all been worked out in the oxidised zone with grade decreasing downwards. Indications are that neither thickness nor grade increase with depth.

III. MARIWA, WITEWATER, SARDINE HILL:

Possible reserves = 333,333 cu.yds at 4.1 gr/cu.yd.
(alluvial) and
350,000 cu.yds. at 5.5 gr/cu.yd.
= 6,850 ozs

This is a minimum figure. No estimates of remaining eluvial material, which may be payable, are available.

CLASS III: HARD ROCK - ALLUVIAL-ELUVIAL PROSPECTS

Three prospects are included in this category and are listed in decreasing order of priority.

I. TASSAWINI:

There is a limited tonnage of enriched material up to a vertical depth of 200'. Some of it has been worked already. The best intersections are 239' at 0.31 oz/ton and 118' at 0.1 oz/ton.

Gold was worked by hydraulicking and gravity, and there are large open pits in the area. This method could probably be used if mining is undertaken here.

This distance between DDH 1 and 2 and the southern boundary of the arsenic anomaly (300 ppm) is about 600', the anomaly is about 1000' wide. Using a depth of 200'.

Speculative reserves = 8,500,000 tons

(assuming none worked)

Assuming 50% remaining

Speculative Reserves left = 4,250,000 tons

II. BARAMITA:

In the past, almost all of the production from this area was obtained from crushed vein material of fairly high grade. However, shafts never exceeded 60' and it appears that gold enrichment does not extend beyond this depth. Diamond drilling failed to locate the veins or mineralisation at depth.

Although some eluvial material has been worked, much of it remains, and can probably be worked. There is very little data, however on these eluvials. Tests at Crocodile and Golden city indicated a recovery of about 0.01 oz/ton from washing alone.

III. HONEY CAMP:

Here again, diamond drilling failed to pick up workable values at depth from veins showing good surface values. Most of the alluvials have been worked out, leaving only eluvial-colluvial deposits to be worked.

Reserves are estimated at 97,000 cu.yds at between

3.42 gr and 2.01 gr/cu.yd.

Minimum reserves = 400 ozs

Maximum reserves = 690 ozs

APPENDIX 15

SECOND SCHEDULE

Table of Fees

	$ ¢
For a Prospecting Licence	5 00
On filing a Notice of Location of any Claim and application for a Licence	50
For filing application for a Concession or Lease	10 00
For a certified copy of particulars relating to a Prospecting Licence	12
For a Licence to mine for gold for each financial year or part thereof	5 00
For a Licence to mine for precious stones for each financial year or part thereof	5 00
For a Licence to mine for gold and precious stones for each financial year or part thereof ...	10 00
For a Licence to mine for valuable minerals for each financial year or part thereof ...	10 00
For a Licence to mine for minerals for each financial year or part thereof	5 00
For filing application for River Location Licence	2 00
For Licence to mine River Location for each financial year or part thereof	20 00
For Goldsmith Licence	1 00
For Georgetown, New Amsterdam and Bartica and within 10 miles thereof -	
Licence to Trade in Gold	300 00
Licence to Trade in Precious Stones ...	700 00
Licence to Trade in Gold and Precious Stones	1000 00
For Licence to trade elsewhere in Gold and/or Precious Stones	100 00
For every duplicate Licence Issued	50
For every duplicate Concession or Lease issued	1 00
For transfer of each claim licence	4 00
For every Mining Privilege	25
For each Certificate, including Registration of Labour	25
For filing Application for Business Permission	5 00

Surveys -

For the survey of any area comprised within the boundaries of a tract to be held under a Claim Licence, Concession or Lease, the applicant shall deposit the estimated cost of the survey and where the actual cost exceeds the amount deposited, shall pay the excess cost after survey, and similarly where

the actual cost is less than the amount deposited, shall be entitled to a refund of the difference.

Fees in proceeding before the Commissioner or Warden -

	¢
Filing Complaint	50
Summons of a Witness	25
Copy of evidence or any document, per page of eighteen lines	12

Source: Government of Guyana, Mining Act, 1973.

APPENDIX 15

Summary of Estimates of Revenue

	1974	1973	1972	1971	1970	1969	1968	1967	1966	1965
Royalty (Stone)	8,200	8,140	30,888	18,830	26,219	43,382	20,076	13,715	14,186	3,258
Mines (Fees)	10,000	3,610	5,196	4,095	4,278	2,291	6,346	4,125	8,843	9,460
Licences (Prospection)	3,700	3,376	3,367	3,101	3,585	5,100	5,423	5,550	4,005	5,635
Licences Claims (Gold)	2,500	2,040	2,132	1,245	7,605	1,860	1,490	1,461	1,995	1,790
Licences Claims (Precious Stones)	18,000	15,615	16,482	16,035	17,382	23,031	24,429	21,691	17,910	19,916
Licences (Other)	100	1,264	130	225	300	366	230	230	211	230
Licences (Oil Exploration)	31,300	70,500	55,407	32,550	133,750	108,503	130,675	105,725	---	---
Mining Priveledges	500	449	362	453	323	622	743	950	655	996
Exclusive Permission	1,600	6,540	123,253	124,926	125,276	88,641	25,642	37,702	24,155	23,428
Concessions - Mining	500	94	310	401	310	94	540	324	324	324
Concessions - Dredging	600	---	2	197	197	197	769	197	7,161	197
Royalties	322,300	592,219	486,092	570,985	551,355	850,477	580,569	629,965	407,677	306,521
Registration - Mining Labourers	---	---	18	---	15	11	14	---	55	32
Mining Leases	4,900	183	4,903	4,903	17,553	10,115	15,443	17,931	18,288	8,020
Lapidiary Lab	---	561,348	---	---	---	---	---	---	---	---

Source: Government of Guyana Estimates of Current and Capital Expenditures.

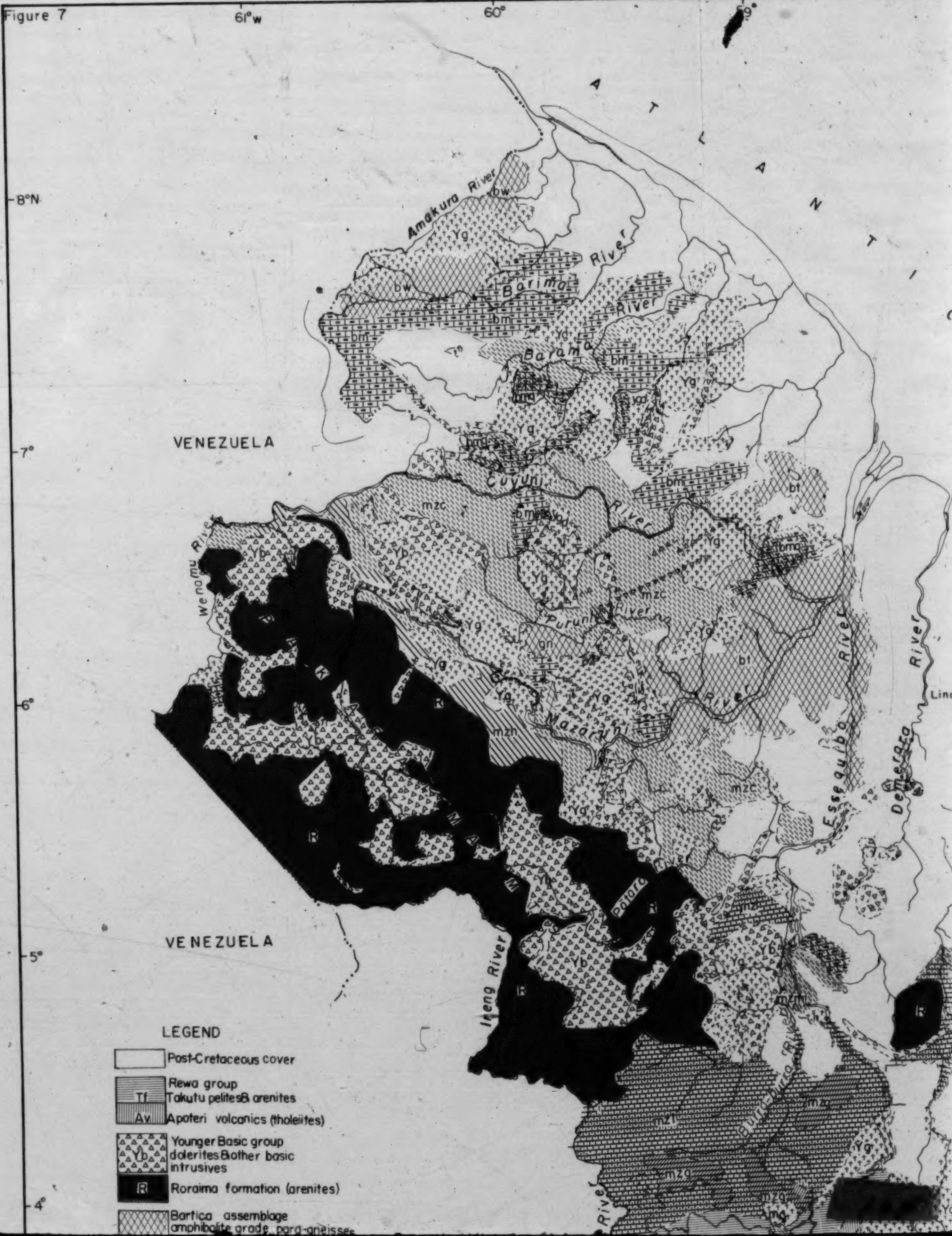
APPENDIX 15

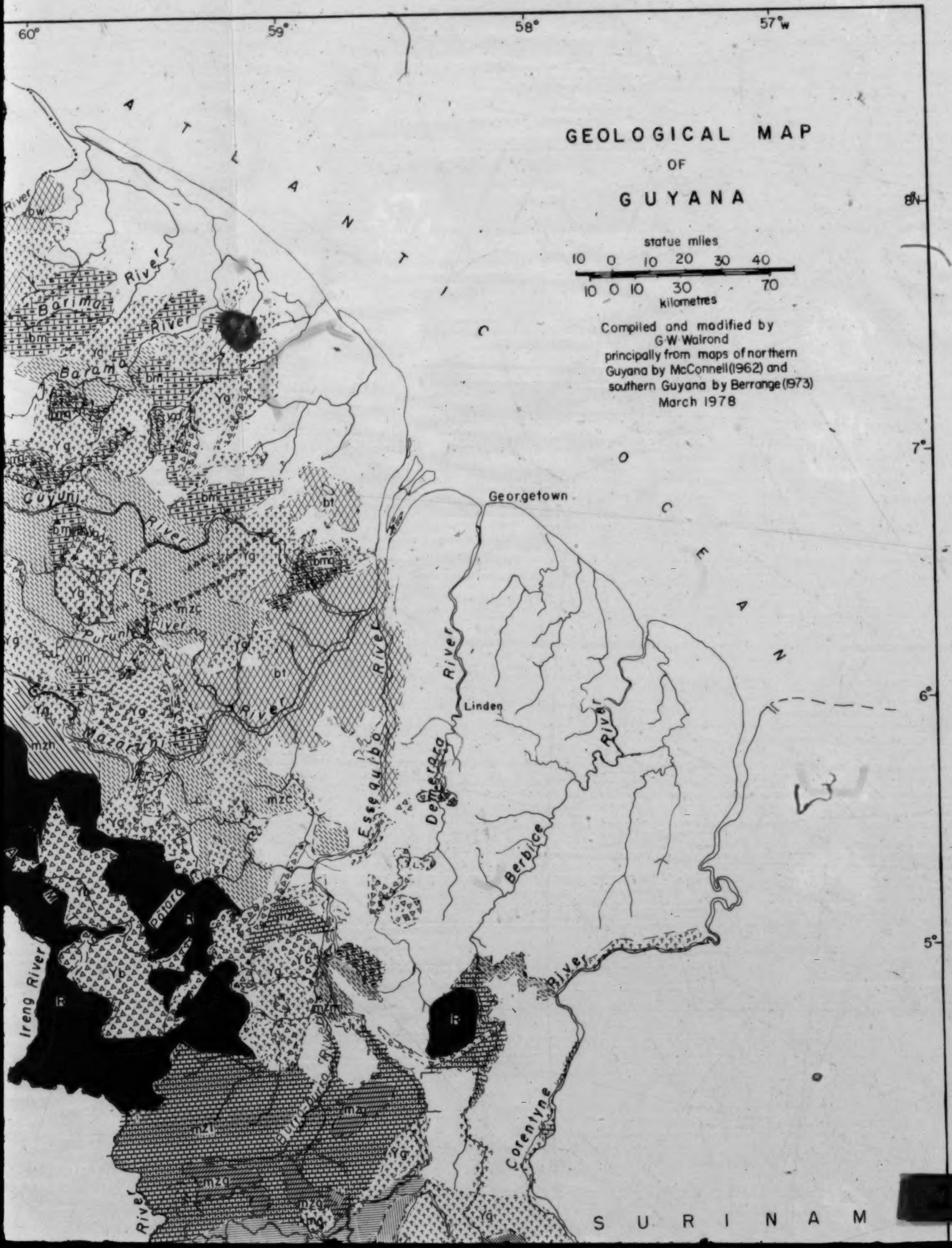
Summary of Estimates of Revenue

	1974	1973	1972	1971	1970	1969	1968	1967	1966	1965
Royalty (Stone)	8,200	8,140	30,888	18,830	26,219	43,382	20,076	13,715	14,186	3,258
Mines (Fees)	10,000	3,610	5,196	4,095	4,278	2,291	6,346	4,125	8,843	9,460
Licences (Prospection)	3,700	3,376	3,367	3,101	3,585	5,100	5,423	5,550	4,005	5,635
Licences Claims (Gold)	2,500	2,040	2,132	1,245	7,605	1,860	1,490	1,461	1,995	1,790
Licences Claims (Precious Stones)	18,000	15,615	16,482	16,035	17,382	23,031	24,429	21,691	17,910	19,916
Licences (Other)	100	1,264	130	225	300	366	230	230	211	230
Licences (Oil Exploration)	31,300	70,500	55,407	32,550	133,750	108,503	130,675	105,725	---	---
Mining Priveledges	500	449	362	453	323	622	743	950	655	996
Exclusive Permission	1,600	6,540	123,253	124,926	125,276	88,641	25,642	37,702	24,155	23,428
Concessions - Mining	500	94	310	401	310	94	540	324	324	324
Concessions - Dredging	600	---	2	197	197	197	769	197	7,161	197
Royalties	322,300	592,219	486,092	570,985	551,355	850,477	560,569	629,965	407,677	306,521
Registration - Mining Labourers	---	---	18	---	15	11	14	---	55	32
Mining Leases	4,900	183	4,903	4,903	17,553	10,115	15,443	17,931	18,288	8,020
Lapidiary Lab	---	561,348	---	---	---	---	---	---	---	---

Source: Government of Guyana Estimates of Current and Capital Expenditures.

Figure 7

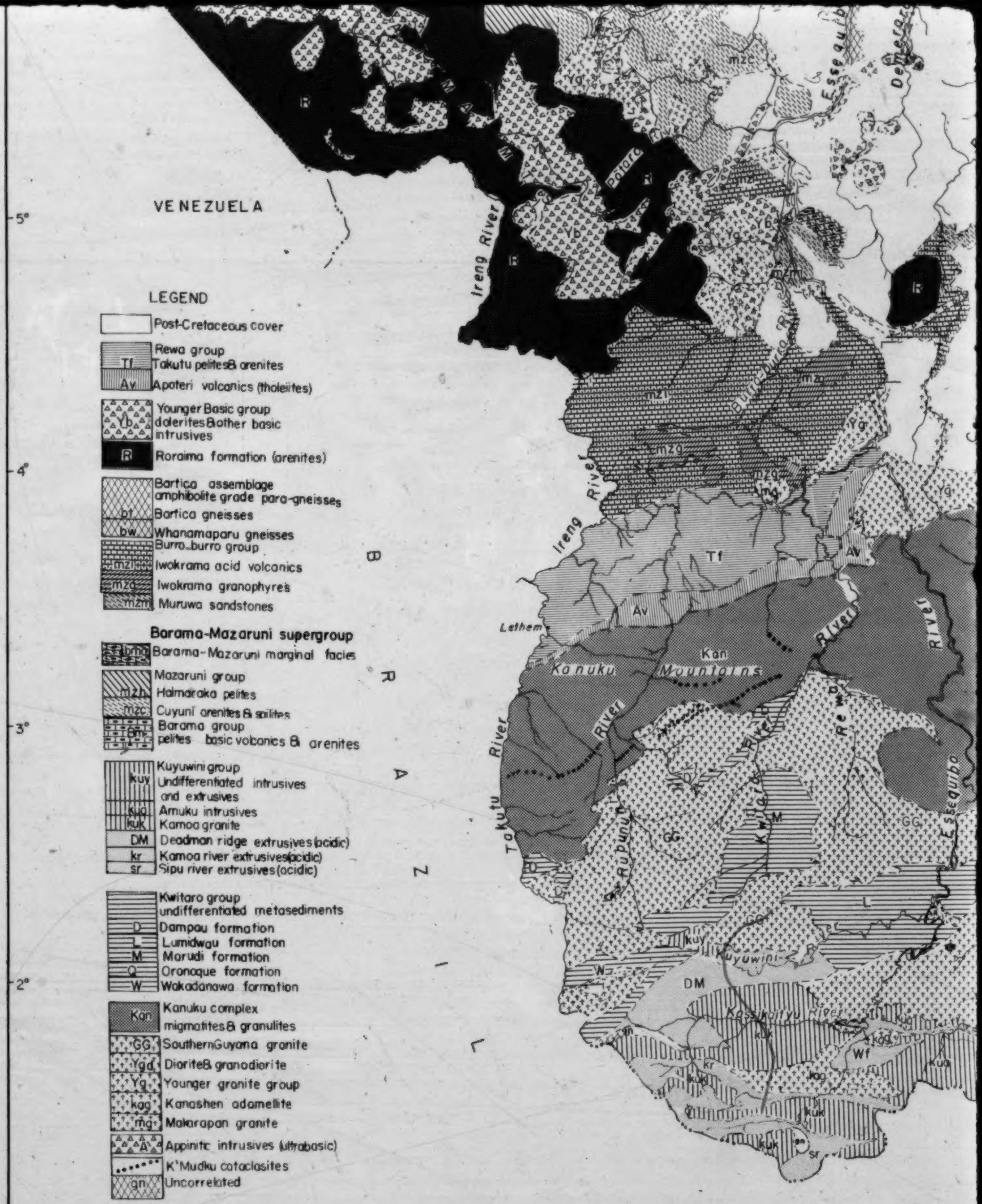

61°w
60°
59°
8°N
7°
6°
5°
4°
A T L A N T I C
VENEZUELA
VENEZUELA
Amakura River
Barima River
Barama River
Cuyuni River
Wenamu River
Puruni River
Mazaruni River
Essequibo River
Demerara River
Potaro River
Ireng River
Burro-burro River
River
Lin
bw
bm
bmq
gd
Yg
Yb
R
mzc
mzh
mzi
mzq
mzg
mzm
bt
gn
LEGEND
Post-Cretaceous cover
Rewa group
Tf Takutu pelites& arenites
Av Apoteri volcanics (tholeiites)
Yb Younger Basic group dolerites&other basic intrusives
R Roraima formation (arenites)
Bartica assemblage amphibolite grade para-gneisses



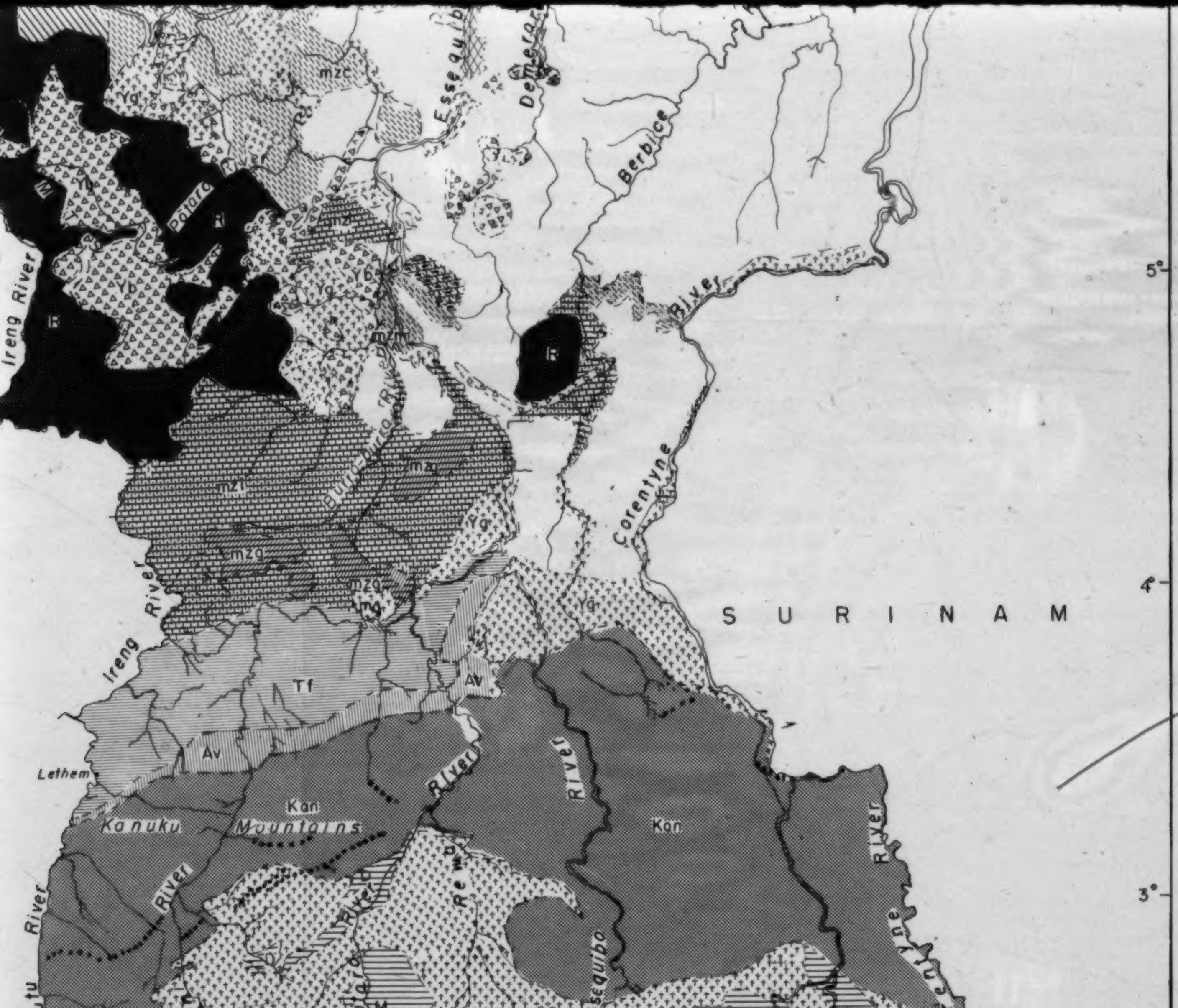
GEOLOGICAL MAP OF GUYANA

Compiled and modified by
G.W. Walrond
principally from maps of northern
Guyana by McConnell (1962) and
southern Guyana by Berrange (1973)
March 1978

60°
59°
58°
57°W
8°N
7°
6°
5°
statue miles
10 0 10 20 30 40
10 0 10 30 70
kilometres
ATLANTIC OCEAN
SURINAM
Georgetown
Linden
Barima River
Barama River
Cuyuni River
Puruni River
Mazaruni River
Essequibo River
Demerara River
Berbice River
Corentyne River
Potaro River
Ireng River
Burro-burro River
River
bw
bm
Yg
Yg'
ygd
bmg
bt
mzc
gn
mzh
Yb
R
mzl
mzg


VENEZUELA
B R A Z I L
LEGEND
Post-Cretaceous cover
Rewa group
Tf Takutu pelites & arenites
Av Apoteri volcanics (tholeiites)
Yb Younger Basic group dolerites & other basic intrusives
R Roraima formation (arenites)
Bartica assemblage amphibolite grade para-gneisses
bt Bartica gneisses
bw Whanamaparu gneisses
Burro-burro group
mzi Iwokrama acid volcanics
mzg Iwokrama granophyres
mzm Muruwa sandstones
Barama-Mazaruni supergroup
bmg Barama-Mazaruni marginal facies
Mazaruni group
mzh Haimaraka pelites
mzc Cuyuni arenites & spilites
Bm Barama group pelites basic volcanics & arenites
kuy Kuyuwini group Undifferentiated intrusives and extrusives
kua Amuku intrusives
kuk Kamoa granite
DM Deadman ridge extrusives (acidic)
kr Kamoa river extrusives (acidic)
sr Sipu river extrusives (acidic)
Kwitaro group undifferentiated metasediments
D Dampau formation
L Lumidwau formation
M Marudi formation
O Oronoque formation
W Wakadanawa formation
Kan Kanuku complex migmatites & granulites
GG Southern Guyana granite
Ygd Diorite & granodiorite
Yg Younger granite group
kag Kanashen adamellite
mg Makarapan granite
A Appinitic intrusives (ultrabasic)
K'Mudku cataclasites
gn Uncorrelated
5°
4°
3°
2°
1°N
61°w
60°
59°
Ireng River
Ireng River
Potaro
Essequibo
Demerara
Burro-burro River
Lethem
Kanuku Mountains
Takutu River
River
Rupununi
Kwitaro River
Rewa River
Essequibo
Kuyuwini River
Kassikaityu River
R
Yb
Yg
mzc
mzi
mzg
mzm
Tf
Av
Kan
GG
M
L
D
W
kuy
DM
kuk
kua
kag
Wf
kr
sr
gn

37


Essequibo
Demerara
Berbice
Potaro
Ireng River
mzc
Yg
Yb
R
Burro-burro R.
mzg
mg
Corentyne River
SURINAM
Tf
Av
Lethem
Kanuku Mountains
Kan
Takutu River
Rupununi River
Rewa River
Kwitaro River
Essequibo River
New River
Oronoque River
Corentyne River
GG
M
L
Q
ug
kuy
Kuyuwini R.
DM
Kassikaityu River
kuk
kug
kog
Wf
kr
sn
sr
5°
4°
3°
2°
1°N
60°
59°
58°
57°W

4/94